SCIENCE

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Dr. Robert L. Fullman, B. Eng., D. Eng., Yale University, joined the staff of the General Electric Research Laboratory in 1948. His fields of specialization include studies of microstructure in metals and alloys, recrystallization, and grain growth. Since 1955 he has been manager of the *Materials and Processes Studies Section.*

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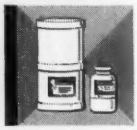

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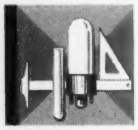

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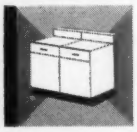

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Scientific Information in the U.S.S.R.

All scientifically advanced countries have to cope with the problem of distributing the enormous world-output of scientific and technical information to their own research workers and technicians. That more international cooperation in handling information might be helpful is recognized by the National Academy of Sciences, the National Science Foundation, and the American Institute of Documentation in their sponsorship of the 1958 International Conference on Scientific Information.

The international conference itself is still a long way off, but in the meantime it may be of interest to discuss the way information is handled in the Soviet Union. D. Yu. Panov, who was here to help plan the conference, is the director of the All-Union Institute of Scientific and Technical Information of the Academy of Sciences of the U.S.S.R. Before returning to the Soviet Union, Panov described the organization and activities of his institute in a talk at the National Academy of Sciences in Washington on 19 September.

The institute, which was established 3 years ago, has 1800 staff members and publishes 13 abstracting journals, which annually contain about 400,000 abstracts from some 10,000 journals. All journals are received by the institute and sent to appropriate sections where the individual papers are classified. If only one copy of a journal is available, it is photographed or taken apart so that appropriate papers can be sent to the editors of the proper abstracting journals. The editors then assign the papers to the 13,000 professional scientists and engineers who prepare the abstracts. Most of the abstractors are members of other specialized institutes or are employed in industry.

Panov pointed out one special advantage of the centralized operation of abstracting services. Selection of papers for abstracts in *Chemical Abstracts* in the U.S. involves search through some 6000 journals, relatively few of which are exclusively devoted to chemistry. The central operation in the Soviet Union permits classification of the chemical and nonchemical papers at the same time. Thus, for example, many papers in biology will be found in journals surveyed for chemical papers. By surveying a comparatively small number of additional journals, it is possible to obtain all of the papers needed for the preparation of biological abstracts as well.

The preparation of abstracts is, in the Soviet Union, as it is elsewhere, a time-consuming process. To meet the needs of industry for up-to-date information, the institute publishes 20 series of "express" journals in the fields of mining, metallurgy, forging, and so on. These publish abstracts of articles within 2 to 3 weeks after receipt.

Among other additional activities, the institute compiles technical foreign language dictionaries (Russian-English, English-Russian, Chinese-Russian, Swedish-Russian, and so on) and is doing work on the mechanical search for information and mechanical translation. The institute also provides another service that must be of considerable help to scientists. It will, upon request, supply any recipient of the abstracts with a complete translation of any paper in any language.

American and other non-Soviet scientists uniformly report, sometimes with some expression of astonishment, that Soviet scientists are very much up-to-date in their information about scientific and technical work in other countries. There are no longer any grounds for astonishment.—G. DuS.

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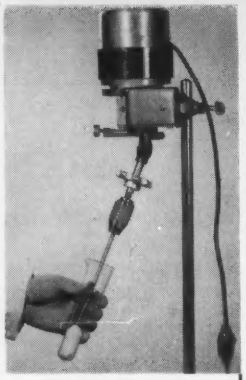

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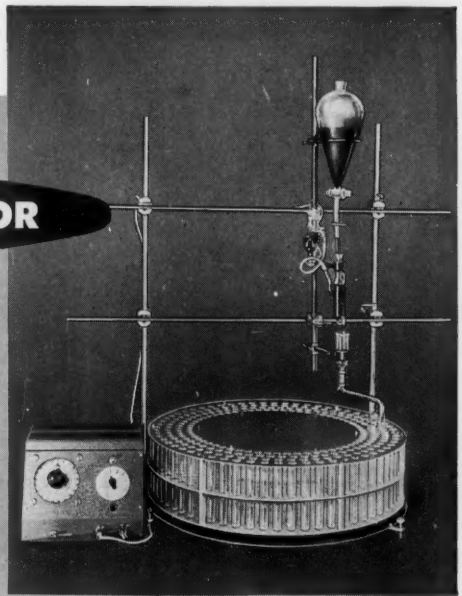

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Origin of the Elements in Stars

F. Hoyle, William A. Fowler,
G. R. Burbidge, E. M. Burbidge

Experimental (*1, 1a*) and observational (*2–6*) evidence has continued to accumulate in recent years in support of the theory (*7–10*) that the elements have been and are still being synthesized in stars. Since the appearance of a new and remarkable analysis by Suess and Urey (*11*) of the abundances of the elements, we have found it possible to explain, in a general way, the abundances of practically all the isotopes of the elements from hydrogen through uranium by synthesis in stars and supernovae. In this article we wish to outline in a qualitative fashion the essentially separate mechanisms which are required in stellar synthesis (*12*).

Thermal Conversion of Pure Hydrogen through Helium to Iron

As long as extremely high temperatures in excess of 5×10^9 degrees Kelvin are not under consideration, the general tendency of nuclear reactions inside stars is to increase the average binding energy per nucleon. For a given temperature and density and for a given time scale of operation of the nuclear processes, the increase of binding that takes place is usually limited by Coulomb effects, but, subject to this limitation, the binding becomes as large as possible. That is to say, energy is degraded as fast as is consistent with Coulomb barrier effects, mitigated in some cases by resonance penetration. Since barrier effects become less severe as the temperature increases, it follows that the binding energies increase with temperature. This will become clear from the following examples.

At temperatures from about 10^7 to 5×10^7 degrees in main-sequence stars, hydrogen is transformed to helium, $4H^1 \rightarrow He^4$, with an average binding energy of 7.07 million electron volts (Mev) per nucleon. We emphasize that the proton-proton sequence of reactions makes possible the production of helium starting only with hydrogen. The recent discovery of the free neutrino as reported by Cowan *et al.* (*1a*) leads to increased confidence in the existence of the primary proton-proton interaction which proceeds through prompt electron-neutrino emission. At temperatures from 10^8 to 2×10^8 degrees in red giant stars, He^4 is transformed principally to C^{12}, O^{16}, and Ne^{20} with an average binding energy of 7.98 Mev per nucleon. The important roles of the ground state of Be^8 and of the second excited state of C^{12} in expediting the primary process of helium fusion, $3He^4 \rightarrow C^{12}$, have recently been clarified (*1*), and it is now clear that the long-standing difficulties in element synthesis at mass 5 and mass 8 are bypassed in this process. At temperatures of the order 10^9 degrees, Mg^{24}, Si^{28}, S^{32}, A^{36}, and Ca^{40} are formed from the carbon, oxygen, and neon, the average binding thus rising to 8.55 Mev per nucleon, while, at temperatures from 2×10^9 to 5×10^9 degrees, Fe^{56} and neighboring nuclei are synthesized, yielding an average binding energy of 8.79 Mev per nucleon. No higher binding than this exists, so that further heating of material will not synthesize in quantity elements of appreciably greater atomic weight than Fe^{56}.

The situation, then, is that a thermal "cooking" of pure hydrogen yields principally He^4 and the α-particle nuclei with $A = 4n$, $Z = 2n$, $n = 3, 4, 5, 6, 7, 8, 9$, and 10 (C^{12} to Ca^{40}), together with nuclei centered around Fe^{56}. These are the most abundant nuclei. Moreover, the relative abundances that have been calculated for these nuclei, and particularly for the 20-odd isotopes of titanium, vanadium, chromium, manganese, iron, cobalt, and nickel, show good agreement with observed abundances. The original equilibrium calculations by Hoyle (*7*) have been considerably improved by taking into account the low-lying excited states of the iron-group nuclei and of the radioactive nuclei which ultimately decay to them, and by statistically weighting each state according to its observed spin or that expected on nuclear shell theory. Typical results for the equilibrium abundances of the chromium isotopes at 3.8×10^9 degrees are indicated in Table 1.

We regard results similar to those presented in Table 1 as giving strong support to the view that the elements under consideration were synthesized inside stars and that they became subsequently distributed in space, either by slow emission from late-type giants or by catastrophic explosion, as for instance in supernovae.

Thermal Reactions of Hydrogen and Helium with Light Elements

More complicated effects arise when the thermal cooking is considered, not of completely pure hydrogen, but of hydrogen adulterated with a small proportion of the elements mentioned in the previous paragraphs. When a second-generation star condenses, the hydrogen out of which it forms will in general have been adulterated by other elements—for example, C^{12}, O^{16}, Ne^{20}, and Fe^{56}—that are synthesized by, and ejected from, previously existing stars. Mixing of core and envelope material in the giant stage of a star may also lead to the same situation.

The presence of the light elements leads to the conversion of hydrogen to helium through the catalytic carbon-nitrogen-oxygen and neon-sodium cycles. In these cycles, the isotopes C^{13}, N^{14}, N^{15}, O^{17}, Ne^{21}, Ne^{22}, and Na^{23} are produced. Eventually O^{18} and F^{19} are pro-

Dr. Hoyle, a fellow of St. John's College, Cambridge University, is visiting professor of astronomy at Mount Wilson and Palomar Observatories, Carnegie Institution of Washington and California Institute of Technology. Dr. Fowler is professor of physics at Kellogg Radiation Laboratory, California Institute of Technology. Dr. G. R. Burbidge is a Carnegie fellow at Mount Wilson and Palomar Observatories. Dr. E. M. Burbidge is a research fellow at Kellogg Radiation Laboratory.

duced in helium reactions, so that all the isotopes of the elements from carbon to sodium are accounted for.

Stellar Surface Reactions

Only deuterium and the isotopes of lithium, beryllium, and boron among the light elements cannot be produced in stellar interiors. They are disintegrated rather than synthesized by interaction with hydrogen and helium at energies that correspond to temperatures in stellar interiors. The possibility that they are produced by high-energy protons and alpha particles in hot spots on stellar surfaces has been previously discussed (*9*). There is now some evidence for such particles from observations in radio astronomy. The frequency-time curve of type-III bursts in radio noise from the sun (*4*) indicates propagation of the agent of noise excitation through the solar corona at velocities from 3×10^9 to 10×10^9 centimeters per second. If such velocities are attributed to protons, the energies of these particles are 5 to 50 Mev. It is to be expected that, in the magnetic stars, acceleration to even higher energies and on a greater scale will take place. At such energies, neutrons, alpha particles, and lithium, beryllium, and boron nuclei will be produced by spallation processes. The neutrons will diffuse from the hot spots into quiescent regions and will there be primarily captured by hydrogen to form deuterium, with the emission of 2.23-Mev radiation (which may eventually prove to be detectable). The deuterium, in turn, when accelerated, may lead to production of anomalous abundances of the heavy elements through stripping reactions (d,p and d,n) and subsequent neutron capture. Anomalous abundances are seen (*9*) in magnetic stars that, unlike the sun, have shallow convective zones in their outer envelope. The acceleration of the particles is probably due to time-varying magnetic fields in the hot spots. Those particles that escape from the stellar surface may be further accelerated to cosmic-ray energies in interstellar magnetic fields.

Neutrons

During the $H \rightarrow He^4$ stage of second-generation stars, Ne^{20} is processed by the reactions $Ne^{20}(p,\gamma)Na^{21}$, $Na^{21}(\beta^+)Ne^{21}$. During the latter stage of the phase, $He^4 \rightarrow C^{12}$, O^{16}, Ne^{20}, free neutrons are generated by $Ne^{21}(\alpha,n)Mg^{24}$. The free neutrons are partly added to the light elements with $A = 4n$, producing the remaining isotopes of these elements, and are partly added to Fe^{56} and allied nuclei. Because the Fe^{56} is present in only very low abundance, the number of neutrons thus made available per Fe^{56} nucleus is approximately 10 to 200, which is sufficient to build the iron into the heaviest elements. Most important of all is the fact that neutrons are produced in a medium primarily composed of He^4, which does not capture neutrons. If He^5 were stable, its production by neutron capture in He^4 would consume all available neutrons and heavy-element synthesis would not be possible. In theories of primordial synthesis, the break in the neutron-capture chain at He^4 has been an insuperable stumbling block. In contrast, it is the saving factor in stellar neutron synthesis. We emphasize that there are no Coulomb electric barrier effects in synthesis of the heavy elements by a succession of neutron captures. Each capture or addition increases the atomic weight approximately by one unit.

Table 1. Equilibrium abundances of the chromium isotopes at a temperature of 3.8×10^9 degrees.

Isotope	Binding energy per nucleon (Mev)	Log abundance relative to Cr^{52}	
		Calculated	Observed
Cr^{50}	8.706	−1.89	−1.27
Cr^{52}	8.776	0.00	0.00
Cr^{53}	8.760	−0.85	−0.94
Cr^{54}	8.778	−1.78	−1.50

We have distinguished two conditions under which the neutron capture can take place, a slow (*s*) process and a rapid (*r*) process. Suess and Urey (*11*) and Coryell (*13*) have already pointed out that the peaks in the abundance curves at stable nuclei with filled neutron shells ($A = 90$, $N = 50$; $A = 139$, $N = 82$; $A = 208$, $N = 126$) strongly indicate the operation of the *s*-process in element synthesis and that the nearby peaks at $A = 82$, 130, and 194, shifted by $\delta A \sim 8$ to 14, similarly require the operation of the *r*-process. The *s*-process we associate with giant stars that evolve in approximately 10^5 years. We regard the observed presence (*2*) of technetium in the atmospheres of the giant S-type stars as a demonstration that the building of very heavy elements by neutron addition actually takes place in stars. The *r*-process we associate with the explosion of supernovae, the time scale being as small as 10 to 100 seconds. We regard the observed 55-day decay of the light curves of type I supernovae as giving strong support to this view, for an explanation of this decay seems to demand (*5*) the building of Cf^{254} in a process of very rapid neutron addition. The 55-day spontaneous fission decay of Cf^{254} is the source of energy dominating the light emission of the supernovae after maximum. The production (*6*) of Cf^{254} in the thermonuclear test at Bikini in November 1952 demonstrates that rapid neutron capture can surmount spontaneous radioactivity. In spite of the extreme provincialism implied, we have been able to find no other nucleus with the unique property of Cf^{254}—a 55-day half-life decay by spontaneous fission in which some 200 million electron volts of energy is released with little or no competition by low-energy alpha-particle decay.

Certain isotopes of the heavy elements can be built only by the *r*-process, while other isotopes can be built only by the *s*-process. The two processes differ in this respect because they allow very different times for the occurrence of the beta disintegrations that occur along the chain of nuclei built by the neutron addition. The *s*-process involves neutron captures in the stable elements or those with life times greater than 10^3 years. Most beta-active nuclei produced in the process have time to decay before additional capture occurs. On the other hand, the *r*-process involves neutron captures and beta decays with approximately equal reaction times (0.1 to 1.0 seconds) in isobars with neutron excess of approximately 5 to 10, relative to that for the stable species.

Finally, a third set of heavy-element isotopes cannot be built by either the rapid or slow capture of neutrons. Consider, for example, the eight isotopes of the element tellurium (which turns out to be aptly named if we persist in the belief that terrestrial abundances are representative samples of the cosmic products of the many mechanisms of synthesis in stars). The light isotopes ${}_{52}Te_{70}^{122}$ and ${}_{52}Te_{71}^{123}$ and ${}_{52}Te_{72}^{124}$ can be produced only in the *s*-process. In the *r*-process, the ultimate beta decays of the neutron-rich isobars at 122 to 124 produced by rapid neutron addition terminate at stable ${}_{50}Sn_{72}^{122}$, ${}_{51}Sb_{72}^{123}$, and ${}_{50}Sn_{74}^{124}$, which are on the neutron side of the mass valley. On the other hand, the heaviest isotope Te^{130} can be produced only in the *r*-process, where it is the stable product of the decay of neutron-rich isobars of mass 130. In the *s*-process, radioactive Te^{129} with a half-life of 70 minutes has time to decay to I^{129} (half-life 2×10^7 years), and, after another neutron capture, the resultant I^{130} decays in 12.6 hours to Xe^{130}, which is thus produced in the *s*-chain instead of Te^{130}. The isotopes Te^{125}, Te^{126}, and Te^{128} can be produced in either the *s*- or *r*-process, although Te^{128} is produced in the slow capture of neutrons only in a weak side link of the chain resulting from the fact that I^{128} decays 5 percent of the time by positron emission or electron capture. The rarest and lightest isotope, Te^{120}, cannot be built in either process, and we

discuss in a subsequent paragraph the infrequent proton capture processes in which such rare proton-rich isotopes can be produced. Tellurium-120 is about 1 percent as abundant and Te^{122}, Te^{123}, and Te^{124} are about 10 percent as abundant as Te^{128}, and Te^{130}, and thus we assign Te^{126}, which has an abundance comparable to Te^{128}, and Te^{130}, to the *r*-process. Tellurium-125 is an intermediate case, but it follows the trend of the *r*-process, and to this we thus assign its production. In this manner we have been able, in general, to assign all the nuclear species with few exceptions to production by one or the other of the neutron processes or to the rare proton-capture process; in a few cases both neutron processes contribute to the abundance.

These considerations are perhaps made clearer by Fig. 1, which has been produced after the manner of Suess and Urey (*11*) and which shows their abundance data in the region from atomic weight 120 to 150. In this figure, nuclear species produced in the same process are connected by shaded curves, and the general trend of the production by the three processes becomes clear. The magic number peaks noted by Suess and Urey (*11*) and by Coryell (*13*) stand out clearly in both the odd-*A* and even-*A* nuclei.

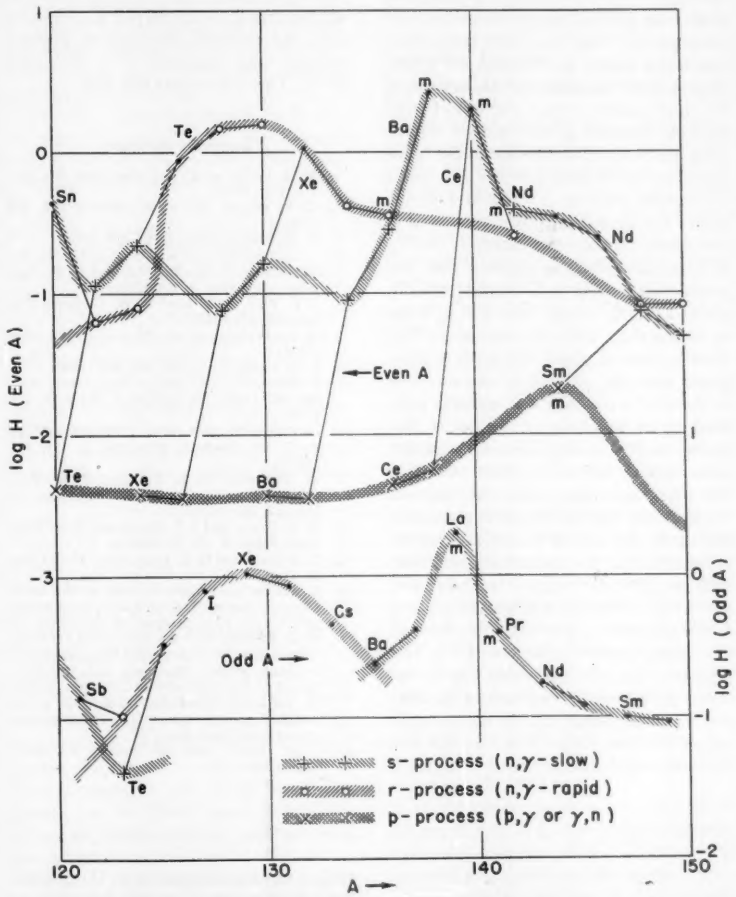

Fig. 1. Logarithm of abundance H (silicon = 6.00, hydrogen = 10.60) from $A = 120$ to 150 according to Suess and Urey (*11*). Odd mass numbers are shown in the bottom curve (read right ordinate). Even mass numbers are shown in the top curves (read left ordinate). Isotopes of a given element are connected by light lines (not to be confused with cross-hatched modes of element synthesis). Nuclei are distinguished by their method of synthesis as follows: +, produced only in neutron capture at a slow rate (*s*-process); ○, produced only in neutron capture at a rapid rate (*r*-process); ●, produced in both processes but predominant mode of production assigned as discussed in text; ×, produced only in proton capture or photoneutron processes (*p*-process). The paths of the three processes are then indicated by the crosshatching indicated in the figure. The stable nuclei with the magic number of closed shell neutrons, $N = 82$, are indicated by *m*. The abundance peak near $A = 139$ follows from the low neutron-capture cross section of the magic stable nuclei in the *s*-process. The abundance peak near $A = 129$ follows from the low neutron-capture cross section and slow beta decay in the *r*-process for the magic neutron-rich isobars (for example, $A = 129$, $N = 82$, $Z = 47$) which eventually decay by beta emission to the stable nuclei in this region. These arguments are based on the fact that in "steady-streaming" the abundance of a given nucleus will be inversely proportional to the rate at which it is transmuted by neutron capture or beta decay. The alternation in abundances exhibited by the sequence Te^{128}, Te^{124}; Xe^{128}, Xe^{130}; and Ba^{134}, Ba^{136} is to be expected in the *s*-process because of the difficulty in adding further neutrons after two have already been captured. In general there is only one isobar at odd mass numbers. However, Te^{125} and Sb^{125} differentiate the *r*- and *s*-processes in an odd *A*-curve. Tellurium-123 is probably unstable but with a very long lifetime.

Capture of Protons and Photodisintegrations

Just as adulteration of the hydrogen of a star by elements up to Fe^{56} is to be expected, so adulteration of the hydrogen by the heavier elements that are built in the *r*- and *s*-processes is to be expected. Such adulteration leads to an interesting additional effect when hydrogen remains unconsumed in the outer regions of a supernova, as it probably does in the case of type I supernovae. In a former paper (*5*), reasons were given for the generation of temperatures of approximately 2.5×10^9 degrees in this hydrogen. At such temperatures (p,γ) reactions occur in a time of the order of 10 seconds, even on the heaviest nuclei (*p*-process). It seems that the proton-rich isotopes of the heavy elements were built in this fashion. These isotopes are characterized by the important property that they cannot be built directly by either the *r*- or *s*-process and that their abundances bear an approximately constant ratio of 10^{-2} to that of those neighboring isotopes that are built by *r*- and *s*-processes. The low value of this ratio, together with its approximate constancy from atomic weight of approximately 70 up to approximately 200, is satisfactorily explained by a process in which a few protons are added at high temperatures to the products of *r*- and *s*-processes. The number of protons that can be added is independent of atomic weight when the energy is large enough that barrier effects are not important at the higher values of atomic weight. This is because proton instability sets in at the same proton excess (approximately 10) relative to the stable nuclei independently of atomic weight. The proton-rich isotopes may also be explained by (γ,n) and (γ,p) reactions at high temperature, operating on the products of the *r*- and *s*-processes.

General Conclusions

The trends of the three processes can be mapped throughout the heavy-element region, and there is reason to believe that the abundance curves will be amenable to quantitative treatment in terms of beta decay rates and of the cross-sections for the neutron- and proton-capture processes. In the past, this has not been possible, for it was not realized that the abundance curve represented a superposition of contributions from several processes. The magic number peaks in the s-process and their shifted counterparts in the r-process are not as pronounced in the over-all abundance curve as they are in the contributing curves. It is already clear that both the slow and rapid neutron-capture processes operated under conditions of "steady streaming." For instance, in the case of the s-process, it appears that the products obtained by multiplying the abundances built through the s-process by the appropriate (n,γ) cross sections of the stable nuclei are remarkably constant from isotope to isotope, as would be expected on the basis of steady streaming. There is one notable discrepancy, in the case of the element lead. Neutron-capture processes should terminate in a cycling among the lead isotopes at the onset of alpha activity. If steady streaming has occurred, there should be a consequent building up of the abundance of lead, and we find that the abundance as given by Suess and Urey (*11*) is too low, by a factor of approximately 10 to 10^2, to be consistent with this.

A consideration of the building of the transuranic elements by the r-process has enabled us to estimate the numbers of progenitors of U^{235} and of U^{238}. Uranium-235 results from the alpha decay which follows the beta decay of the neutron-rich nuclei produced with $A = 235$, 239, 243, 247, 251, and 255. Beyond $A = 259$, the ultimate decay is probably by spontaneous fission rather than by alpha emission. Uranium-235 results from production at $A = 238$, 242, 246, and 250. Thus U^{235} has six odd A progenitors while U^{238} has four even A progenitors. Odd-even pairing energy effects become progressively less important throughout the heavy stable nuclei, and we would expect neutron-capture cross sections to be very nearly equal for odd-A and even-A elements in the heaviest nuclei. This must indeed be the case in the rapid neutron-capture peak near $A = 194$ (similar to the peak at $A = 130$ in Fig. 1), where the abundances of odd A-even A are nearly equal—for example, $Pt^{195}/Pt^{194} = 1.03$. Thus, it appears that the production ratio U^{235}/U^{238} was probably about 1.5 and, in any case, was unlikely to be less than unity. If we suppose that the elements of which the earth is composed were not all built at one moment of time but were built at a uniform rate, starting at the time of origin of the galaxy and extending almost up to the formation of the solar system some 5×10^9 years ago, then, using the ratio of the uranium isotopes found at present in the earth, the age of the galaxy can be calculated. For the case of a production ratio of U^{235}/U^{238} equal to unity, the age is 7.5×10^9 years, while a still greater age is obtained if a production ratio of 1.5 is used for U^{235} relative to U^{238}. The argument for this high value can be restated as follows. At the time of the formation of the solar system, we can calculate that the ratio $U^{238}/^{235} = 3.5$ On the basis of production, either in a single event or continuously, an additional time interval is required to reach the time at which $U^{238}/U^{235} \approx 1$.

Finally, it may be remarked that, since the production of the heavy elements ($A > 60$) is a by-product of ordinary thermal cooking that depends on the adulteration of the hydrogen out of which a star forms, it is to be expected that these elements will be synthesized in abundances that are very low compared with the ordinary products of thermal cooking (for example, O^{16}, Si^{28}, and Fe^{56}). This is precisely the case.

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Nomenclature of Enzymes of Fatty-Acid Metabolism

H. Beinert, D. E. Green, Priscilla Hele, O. Hoffman-Ostenhof, F. Lynen, S. Ochoa, G. Popják, R. Ruyssen

Spectacular developments during the last few years have led to the isolation in a soluble form of a number of enzymes of fatty-acid metabolism in several independently working laboratories. This circumstance resulted in the denoting of enzymes that catalyze similar reactions by different names, either according to the substrate attacked or according to the favored equilibrium of the particular reaction. This could lead to confusion among those not working in the field.

The second International Conference on Biochemical Problems of Lipids, attended by representatives of 20 nations and held between 27 and 30 July 1955 at the University of Ghent, Belgium, under the presidency of R. Ruyssen, gave an opportunity to iron out these difficulties. A special meeting to discuss problems of nomenclature was convened at the conference. A memorandum by Priscilla Hele and G. Popják, London, was presented and formed the basis of the discussions. There was unanimous agreement, and the conclusions reached are presented here.

Suggested Principles

Before we considered individual enzymes, an agreement was reached concerning the broad principles that should govern the nomenclature.

It is recommended that enzymes be called by a systematic name that should

denote the substrate or substrates acted on and the over-all reaction catalyzed (*1*). However, the mechanism of the reaction should not be implicit in the name of the enzyme, for further discoveries may change present-day concepts of reaction mechanisms.

Since the systematic names may be unwieldy in everyday use and even when referred to several times in a publication, it appears highly desirable to have trivial names also. For the trivial name, a shortened version of the systematic name is generally recommended.

While it appears desirable to denote the enzymes according to the favored equilibrium of the reactions, this aim cannot be fully realized where an unwritten convention already exists—for example, in the case of enzymes that catalyze oxidations and reductions. These are usually called "dehydrogenases," irrespective of whether the equilibrium of the reaction favors reduction (reductase) or oxidation (dehydrogenase). A further difficulty may arise in this connection with reactions that have equilibriums lying in opposite directions at different *p*H values. For these reasons, the use of the term *reductase* is not recommended, at least not until the present convention is altered by some future international agreement.

Since it is now well known that, in general, fatty acids are not metabolized unless they are in combination with coenzyme A or other thiols, it is considered unnecessary to include coenzyme A in the terminology. However, in order to indicate that the substrate is not the free acid, it is recommended that the name of the acid radical be used to denote the substrate. For example, *butyryl-dehydrogenase* indicates an enzyme acting on butyryl-coenzyme A; *butyric-dehydrogenase,* on the other hand, would describe an enzyme whose substrate was free butyric acid.

Most of the enzymes of fatty-acid metabolism act on substrates derived from fatty acids of differing (although approximately the same) chain length. It is recommended that in such instances the enzyme be called after that chain length for which it shows the highest affinity, or, if one optimum chain length cannot be defined, after the range of chain lengths involved.

In all instances where "free" coenzyme A may be considered to be a substrate of the reaction (either explicitly or implicitly), the term denoting the function of the enzyme should be preceded by the prefix *thio*—for example, *thiokinase, thiolase, thiophorase.*

Individual Enzymes of Fatty-Acid Metabolism

Individually the enzymes concerned in fatty-acid metabolism were considered under five headings according to the reactions they catalyze. These are (i) activation, (ii) condensation and cleavage, (iii) reduction and oxidation, (iv) hydration and dehydration, and (v) transfer reactions.

Activating enzymes. The reaction catalyzed (*2*) is

$$\text{Fatty acid} + \text{ATP} + \text{CoA} \rightleftharpoons \text{fatty acyl-CoA} + \text{PP} + \text{AMP}$$

It is recommended that this group of enzymes be called *thiokinases,* with a prefix denoting the main substrate attacked. Thus, the first enzyme in the coenzyme A field, that discovered by Lipmann in 1945 (*3*), would be called *acetic-thiokinase* (not *acetyl-thiokinase*). The other two enzymes known in this group, one with a chain-length optimum at C_7–C_8 (*4*) and one with an optimum at C_{12} (*5*) are called accordingly *octanoic* (*caprylic*)*-thiokinase* and *dodecanoic* (*lauric*)*-thiokinase,* respectively. These enzymes at present are generally referred to as "acetate-activating enzyme" (AAE) and "fatty-acid-activating enzymes" (FAAE).

In the construction of the term *thiokinase,* it was considered that, although fatty acyl-coenzyme A may be formed by a number of reactions, the primary activation usually involves a high-energy phosphate group (that of ATP in the case of enzymes of animal origin); thus, the usage of the term *kinase* here is in accord with that current in biochemistry today. It was further agreed that these activating enzymes should be called thiokinases regardless of whether the split of ATP resulted in the production of AMP + pyrophosphate (PP) or in ADP + orthophosphate. Thus the enzyme, discovered by Kaufmann (*6*), which activates succinic acid according to the reaction

$$\text{Succinate} + \text{CoA} + \text{ATP} \rightleftharpoons \text{succinyl-CoA} + \text{ADP} + \text{P}$$

is called *succinic-thiokinase.*

Condensation and cleavage enzymes. The reaction catalyzed is

$$\text{C}_n\text{-fatty acyl-CoA} + \text{acetyl-CoA} \rightleftharpoons \text{C}_{(n+2)}\text{-}\beta\text{-ketoacyl-CoA} + \text{CoA}$$

Lynen *et al.* (*7*) proposed the name "β-ketothiolase" for the enzyme(s) that catalyze(s) this reaction, and Green's group (*4*) proposed "β-ketoacyl CoA cleavage enzyme."

It has been agreed that, although this group of enzymes might also be considered to be transacetylating enzymes, the term *thiolase* is the most appropriate name for this class, for it expresses the essentially thiolytic nature of the reaction, the equilibrium of the reaction lying far in the direction of cleavage. The recommended systematic name is β-*ketoacyl-thiolase;* examples are as follows: *acetoacetyl-thiolase,* β-*ketohexanoyl-thiolase* (or β-*oxohexanoyl-thiolase*), and so forth. The recommended trivial name is *thiolase.*

Enzymes catalyzing oxidations and reductions. It has been recommended (see the foregoing discussion) that all these enzymes should be called dehydrogenases generically, irrespective of the equilibrium of the reactions. There are two reactions considered in this class:

$$\beta\text{-Hydroxyacyl-CoA} + \text{DPN} \rightleftharpoons \beta\text{-ketoacyl-CoA} + \text{DPNH} + \text{H}^+ \quad (1)$$

$$\text{Saturated fatty acyl-CoA} + \text{FAD} \rightleftharpoons \text{unsaturated fatty acyl-CoA} + \text{FADH}_2 \quad (2)$$

Enzymes that catalyze reaction 1 have been described by both Green's and Lynen's groups. Green (*4*) proposed the name "β-hydroxyacyl-CoA dehydrogenase"; Lynen's terminology has been varied: "β-ketohydrase" (*7*), "β-ketohydrogenase" (*8*), and "β-ketoreductase" (*9*).

The recommended systematic and trivial name for enzymes that catalyze reaction 1 is β-*hydroxyacyl-dehydrogenase*; an example is β-*hydroxybutyryl-dehydrogenase.*

Enzymes that catalyze reaction 2 have been described by Seubert and Lynen (*10*) under the name "ethylene reductase," and three enzymes have been described by the Madison group (*4*) under the names "butyryl-coenzyme A dehydrogenase" (green enzyme) and "fatty acyl coenzyme A dehydrogenase" (yellow enzymes, Y_1 and Y_2).

The recommended systematic and trivial name for enzymes that catalyze reaction 2 is *acyl-dehydrogenase;* examples are *butyryl-dehydrogenase, hexanoyl* (*caproyl*)*-dehydrogenase,* and *hexadecanoyl* (*palmityl*)*-dehydrogenase.*

Enzymes catalyzing hydration and dehydration. The reaction catalyzed is

$$\text{Unsaturated fatty acyl-CoA} + \text{H}_2\text{O} \rightleftharpoons \beta\text{-hydroxyacyl-CoA}$$

An enzyme that catalyzes this type of reaction has been described by Green (*4*) and by Ochoa's group (*11, 12*). Green's terminology has been "unsaturated fatty acyl coenzyme A hydrase." Ochoa's group called their enzyme "crotonase" in analogy with fumarase.

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Enoyl-hydrase (or *Enoyl-Hydratase* in German) is recommended as the systematic and trivial name for this group of enzymes; examples are *crotonyl-hydrase* (*but-2-enoyl-hydrase*), *hex-2-enoyl-hydrase, oct-2-enoyl-hydrase,* and so forth.

Since crotonyl-hydrase has been obtained in crystalline form (*13*) and, although of broad specificity, is most active on crotonyl-CoA (*14*), it has been agreed that the term *crotonase* be retained as the trivial name for this enzyme.

Transferring enzymes. Three reactions are known in this group:

Propionate (or butyrate) + acetyl-CoA ⇄ propionyl (or butyryl)-CoA + acetate (3)

Acetoacetate + succinyl-CoA ⇌ acetoacetyl-CoA + succinate (4)

Butyrate + succinyl-CoA ⇌ butyryl-CoA + succinate (5)

The first of these reactions (reaction 3) was discovered by Stadtman in extracts of *Clostridium kluyveri* (*15*). Since the reaction involved the transfer of CoA from acetyl-CoA to an acceptor fatty acid, the name "CoA-transphorase" was proposed for the enzyme(s) responsible (*16*). Stern, Coon, and del Campillo (*17*, see also *11*) have described enzyme preparations that catalyze reaction 4, and Green's group (*4*) has reported on preparations responsible for both reactions 4 and 5.

These enzymes may be considered coenzyme A-transferring enzymes, and accordingly *thiophorase* is recommended as a systematic and trivial name for them. The systematic names for the enzymes that catalyze the three reactions (reactions 3, 4, and 5) listed in this group are: (i) *propionyl-acetic-thiophorase* (or generically, *fatty acyl-acetic-thiophorase*), (ii) *acetoacetyl-succinic thiophorase,* and (iii) *butyryl-succinic-thiophorase.*

The differentiation in denoting the acid substrates with the suffix *-yl* or *-ic* in this instance has been dictated by the equilibrium of the reactions.

We believe that these suggestions represent the beginning of an effort to introduce uniformity into the present, somewhat confused, terminology of enzymes of fatty acid metabolism and hope that this subject will be reconsidered in due course by the Commission on Enzymes of the International Union of Biochemistry.

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André Mayer, Scientist, Soldier, Statesman

André Mayer, who died in Paris on 27 May 1956, was born in that city on 9 November 1875, the son of one of the many Alsatians who had left their native province in 1871 after the German annexation. After distinguished studies at the Lycée Condorcet, he entered the Medical School of the University of Paris at the age of 16, then interned with Charcot. After a few years spent as the senior assistant of Dastre, himself the closest assistant and successor of Claude Bernard, Mayer undertook to equip and staff at his own expense a laboratory in an old house next to the Collège de France, which he maintained until World War I as an active research center.

His first major contribution consisted of several classic papers (1901–05) on thirst. He demonstrated that this sensation arises when osmotic pressure increases, affecting both the mucous membranes of the throat and, more importantly, central structures, or "osmoreceptive centers." This first correlation between a sensation and a physical measurement elicited vivid interest, not only among physiologists and psychologists, but also among philosophers.

In collaboration with Victor Henri, André Mayer established many of the now classic colloidal properties of living matter, including the concept that the structure of protoplasm is that of a gel. With Schaeffer and Terroine, he established the concept of "cellular constants," characterizing the interrelation between various components of each tissue. For example, he demonstrated the relationship between the "lipocytic ratio" (cholesterol: fatty acids) and the degree of hydration of cells. He demonstrated that "physical" properties—for example, osmosis, capillarity, and diffusion—are not adequate to interpret urinary excretion but that tubular reabsorption must involve specific chemical transport and active secretion. His personal friendship with Pierre Curie led Mayer to the first observations of the effects of radioactivity on biological materials. Curie had come to consult him on a skin sore just above the waist, which Mayer correctly surmised to be due to Curie's habit of carrying a small radioactive sample in his right vest pocket. This led him to the first demonstration of the destructive effect of radiation on colloids, cells, and small mammalians. With Armand Delile, Mayer devised in 1913 the first "synthetic" medium for the culture of microorganisms. His field of investigation during that period extended to many other topics, in particular to the study of diabetes: for example, he was the first to examine the effect of superimposing the removal of other endocrines, in particular the adrenals, on pancreatectomy.

Came World War I. André Mayer volunteered immediately and served as regimental surgeon on the Verdun front.

After the German "chlorine wave" at Ypres, he was called back to Paris and appointed by Clemenceau chief of the scientific department of the Allied Chemical Services then being hastily improvised in an atmosphere of gloom. One illustrious chemist expostulated that "no nation could fight a chemical war with Germany." Mayer and his British associate, Joseph Barcroft, rallied their colleagues, fashioned in a few days the first Allied gas masks, and organized the first Allied reprisals. The discovery of the hyperthermic effects of dinitrophenol and of the cellular effects of mustard gas are interesting scientific by-products of his wartime activity. In 1917, Mayer's group was enlarged by the arrival of United States personnel; many of his American collaborators, Walter Cannon, L. J. Henderson, A. M. Pappenheimer, and others, remained his lifelong friends.

In 1919, André Mayer became the first professor appointed by the French Government at the University of Strasbourg. There he planned and initiated the rebuilding of the Medical School and its research institutes. In 1923, he was elected to the Collège de France, in the chair of Cuvier and Marey. Between the two wars he directed there an extremely active laboratory, devoted, among other topics, to the characteristics of the regulation of food intake and of water intake, the relationship between temperature maintenance and oxygen consumption, the relationship of lipogenesis to hydration in plants, and so on.

During the period between the two world wars, André Mayer was also active in strengthening French scientific organizations, a task made all the more urgent by the decimation of educated young men during World War I. He served as president of many of the French scientific societies, varying in object from physical chemistry to psychology, as chairman of the board of the Biological Institute and of the Cancer Institute (Hoover Foundation) at Lille, as secretary general of the French National Research Council, as vice president of the Collège de France, and as head of the Scientific Military High Committee. He was a member of the Académie de Médecine and the Académie des Sciences. Yet he did not seek or enjoy the administrative duties which took him away from his laboratory. He repeatedly declined cabinet appointments as well as the rectorship of the University of Paris. On the other hand, he never refused to undertake any task which could lead to greater international understanding and peace. He served as delegate to the Disarmament Conference, as chairman of the Expert Committee of the International Red Cross, as adviser to the International Labor Office and to the Health Section of the League of Nations. With all this, he found time to write some of the best contemporary French prose. His introduction to volume IV (*Life*) of the French Encyclopedia, which he directed, is considered a literary classic.

World War II found him back in service, with the equivalent rank of lieutenant general, at the head of the Chemical Warfare Services of the Allied command, and later as head of the Fighting French military and medical missions to the United States. In Washington in 1943–44 he worked on the landing plans, was chairman of the Social Council of UNRRA, was one of the chief architects of the Food and Agriculture Organization of the United Nations, serving as chairman of its first executive committee (he later declined to succeed Lord Orr as director general, preferring to remain in a more independent position as chairman of the coordinating committee). He also found time to give the Lowell lectures in Boston.

Back in France at the end of 1944 he took a leading part in the creation of other international organizations, including the International Scientific Unions, on the council of which he later represented physiology. His last years were as busy as his life had always been; at 80 he was still working 12 hours a day as head of public health, agricultural, and military institutions, and as plenipotentiary ambassador to the technical agencies of the United Nations. One month before his death—and 1 month after the death of his cherished wife—he was in Central Africa, inspecting nutrition and technical assistance work.

André Mayer received the highest distinctions from his colleagues, from universities on both sides of the Atlantic, from his own and many allied governments, and from international organizations. But the real measure of his greatness is that all who have had the privilege to know him retain the example of his appetite for knowledge, his disciplined imagination, his care in the execution of any task worth undertaking, his courage and fierce love for freedom, and his utter selflessness—the traits held throughout the ages to be the attributes of the scholar and the humanist.

JEAN MAYER
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Seymour Korkes, Biochemist

With the accidental death of Seymour Korkes at the age of 33, on 10 December 1955, American biochemistry lost one of its most promising young men.

Korkes, a native of New York City, received most of his undergraduate training at Brooklyn College from which he was graduated in 1942. Harry Albaum invited Korkes to become his research assistant when Korkes was under 20. While studying the metabolism of oat seedlings—the subject of the first of Korkes' published scientific papers—with Albaum, Korkes initiated his acquaintance with the biochemical methods used in the study of cell respiration and metabolism. During his senior year in college, Korkes worked with I. N. Korr in the department of physiology, New York University College of Medicine, on the difference in the responses of resting and stimulated tissues to inhibitors of the cytochrome oxidase system.

On graduating from the New York University College of Medicine, Korkes received an Army Medical Corps commission. After serving an internship at Queens General Hospital, he was selected for a position on the teaching and research staff of the division of biochemistry of the School of Aviation Medicine at Randolph Field, Texas. A year and a half later, he joined the staff of New York University College of Medicine as instructor in pharmacology. He was awarded a Markle scholarship in the medical sciences and became assistant professor of pharmacology in 1951.

At Randolph Field, Korkes attacked certain biochemical aspects of the problem of anoxia at high altitudes through studies of the respiration of tissue homogenates at low oxygen tensions and the effect of various metabolites and cytochromes on this respiration.

At New York University, Korkes discovered a new inducible bacterial enzyme, which catalyzed the oxidative decarboxylation of malic acid to lactic acid and carbon dioxide, and elucidated the mechanism of the reaction. His most striking contribution, however, was the demonstration that soluble enzyme preparations from bacteria could catalyze the oxidation of pyruvic acid on addition of diphosphopyridine nucleotide (DPN) and coenzyme A, with the formation of reduced DPN, acetyl coenzyme A, and carbon dioxide. This discovery was rapidly followed by the isolation of similar enzymes from animal tissues. Although the participation of coenzyme A in pyruvate oxidation had been made to appear likely by the work of Lipmann and his collaborators, and the role of acetyl coenzyme A in the enzymatic synthesis of citric acid was essentially established at that time (1950) through work at New York University, the exact nature of the initial steps in the biological oxidation of pyruvate had remained obscure until the time of Korkes' work.

A study by Harold Strecker and Korkes of the glucose dehydrogenase of mammalian liver led to the discovery that the immediate oxidation product of glucose by DPN is the δ-gluconolactone and that the reaction is readily reversible. Oxidation to the lactone had been made to appear likely in the case of glucose-6-phosphate dehydrogenase that is triphosphopyridine nucleotide-dependent by the work of O. Cori and Lipmann and had previously been established by Bentley and Neuberger for the oxidation of glucose by notatin, the glucose oxidase of *Penicillium notatum*. Unlike the liver enzyme, however, notatin is a flavoprotein, and the oxidation of glucose by this enzyme is irreversible.

During 1952 and 1953, Korkes worked as a research guest in the laboratories of Earl R. Stadtman, at the National Institutes of Health, Bethesda, Maryland, and Horace A. Barker at the University of California in Berkeley. In September, 1953, Seymour Korkes joined the staff of the Duke University School of Medicine as associate professor of biochemistry in Philip Handler's department. At Duke University Korkes continued work that he had started in Bethesda on the mechanism of the biological reduction of certain metabolites by molecular hydrogen catalyzed by the enzyme hydrogenase.

Delving deeper into nature's secrets, he was investigating the idea that biological reduction by hydrogen might operate through the same basic patterns as the reduction occurring in photosynthesis through the photochemical cleavage of water and that a common step, possibly the reduction of pyridine nucleotides, might be involved. This idea was partly based on experimental results of Korkes himself and of Wolf Vishniac with chloroplast and bacterial preparations at New York University.

The initial results of this work provided a clear-cut demonstration that the hydrogenase system present in soluble enzyme preparations of the microorganism *Clostridium kluyveri* very actively catalyzed the reduction of diphospho- and triphosphopyridine nucleotides by molecular hydrogen; furthermore, as yet unidentified heat-stable cofactors were required for this reaction.

During most of 1955 Korkes had been working hard on the preparation of the review on carbohydrate metabolism for volume 25 (1956) of the *Annual Review of Biochemistry*. He had given considerable thought to this review and had prepared a number of notes on the various topics with highly original and stimulating ideas on some of them. It is very fortunate that, through the efforts of Philip Handler, George W. Schwert, Efraim Racker, Sidney P. Colowick, B. L. Horecker, Seymour Kaufman, Nathan O. Kaplan, and other friends, this last contribution of Seymour Korkes will be available to biochemists and physiologists as a posthumous paper.

Because of his lucid intelligence, his keen imagination, his rapidity in grasping concepts and ideas, and his uncommonly broad background in mathematics, physics, chemistry, and the biological sciences, Korkes was exceptionally well endowed as an investigator. These qualities, together with his clarity of expression, his unselfishness, and his desire to help other people, made him a teacher of unusually high caliber. His kind, modest, and inspiring personality and his warm friendliness gained the sympathy and confidence of students as well as that of his colleagues. His conversation, full of youthful, overflowing enthusiasm or of searching criticism, was highly stimulating, and one was captured by the warmth and intellectual integrity with which he defended or criticized ideas and experiments.

Korkes had wide interests, and he was equally at home whether he was performing a biological experiment or was engaged in the construction of electronic equipment, in glassblowing, or in various other activities. These qualities made him very resourceful in the laboratory. He was a man of more than average culture and had the fortune of sharing his wide interests in literature, painting, music, and art in general with his gifted wife, Frieda. Seymour Korkes will always be remembered by his friends and colleagues with admiration and deep affection.

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News of Science

Former Members of AEC Comment on Its Present Policies

The United States may lose world leadership in peaceful atomic energy development within a year unless all information restrictions in this field are promptly removed, according to Gordon Dean, former chairman of the Atomic Energy Commission. In an address delivered during the University of Michigan's national institute on the legal problems of atomic energy, Dean said information restrictions contained in American bilateral agreements for peaceful atomic development were making many foreign lands look elsewhere for leadership and assistance in this field.

He cited Japan as a specific example of a nation hungry for nuclear power development that was unwilling to enter a bilateral agreement with the United States because of these restrictions. Western European nations are turning more and more to one another for help in this work rather than to this country. Dean said some restrictions on the distribution of nuclear material were necessary to prevent its diversion to military purposes in foreign lands. But he observed that so far as information is concerned, the United States has no really effective means of policing security regulations in other countries.

Henry DeWolf Smyth, another former member of the AEC, in an article published in a recent issue of *Foreign Affairs*, also condemns the commission for withholding information that is not vital to American security. He says: "We need a clear decision that information of direct and immediate military value should remain classified and that all other information should be declassified. . . . Such a decision would release our work on the controlled thermonuclear reaction from the bonds of secrecy in which it is now entangled and would release other more prosaic data which our rivals can eventually get for themselves if they haven't already."

Chiefly, Smyth's article was devoted to criticism of the Government for its failure to fulfill its obligation to the nation's atoms for peace program, which he describes as both "feasible and desirable."

Pointing out that "we do not have a single plant in operation producing significant amounts of commercial power from nuclear energy," Smyth asks, "How can we offer to build reactors abroad without building enough reactors here to know what we are doing?

"We cannot simultaneously make 'atoms for peace' a major part of our foreign policy and atoms for private industry a controlling part of our domestic policy. . . . However desirable it may be to get the Government out of the nuclear power business, it is more important to back our announced foreign policy with a vigorous and fast-moving program of reactor development and construction."

Malaria and Sickle-Cell Anemia

Much interest has centered on the racial distribution of the gene that is responsible, in the heterozygous state, for sickling of the red blood cells when oxygen is withdrawn and, in the homozygous state, for fatal sickle-cell anemia. The type of hemoglobin which characterizes the sickle cells is largely limited to Negro peoples (exceptions: some Greek populations and the Veddoids of India). Since in some African tribes the frequency of sickling rises locally to 45 percent of individuals, potent factors must be at work to keep this gene from eliminating itself by natural selection. A high mutation rate to sickling from the alleles for other types of hemoglobin has been suggested as a possible cause; but the alternative explanation of a selective advantage favoring the heterozygous sicklers over the nonsicklers has been widely accepted since A. C. Allison's demonstration in 1954 that sicklers were significantly more resistant to infection with tertian malaria than nonsicklers of the same tribe.

Some doubt lingered because great differences in frequency occur in adjacent tribes, and because it seemed unlikely that the mortality from malaria could push frequencies of sickling to the observed heights. These doubts seem to be dispelled by a recent study conducted by H. Lehmann and A. B. Raper [*Brit. Med. J.*, p. 333 (11 Aug. 1956)]. They examined the Baamba of Uganda, a tribe in which the sickling incidence is at the "very high frequency of 39 percent." The Bwamba district in which the tribe lives is highly malarious. First the investigators undertook to determine whether or not any homozygotes for sickling hemoglobin ever survive to adulthood under African conditions. The sample of 227 sicklers should have contained at least five adult sickling homozygotes. Surprisingly, none were found. Thus, sickle-cell anemia seems to be as highly fatal in Africa as elsewhere. The frequency of infection with malaria (both common and tertian) in the years under age 10 approached 80 percent, the two forms being about equally common. Total childhood mortality in the population was at least 58.8 percent and probably higher.

It could be calculated that the death of homozygous nonsicklers from malaria which would be needed to counterbalance the loss of sickling genes from the tribe would at a maximum be 24.2 percent and, if mortality from other causes than malaria was antecedent to or concurrent with that from malaria, it might be as low as 10.6 percent. Hence, "no very high malaria death rate need be recorded if the loss from other diseases is high, and especially if a large proportion of that loss consists of neonatal deaths." What seems particularly significant is the conclusion that different sickling frequencies would be expected in tribes where the infant mortality picture is different.—B. G.

Satellite and Its Vehicle

Test firings of an earth-satellite vehicle will begin at the Air Force missile test center at Cocoa Beach, Fla., this fall, probably in November. The rocket vehicle will be similar to the one that later will carry the earth satellite into space. The third, or top, stage of what eventually will be a three-stage vehicle will be carred aloft in a modified Martin Viking rocket. It is considered unlikely that any part of the test vehicles will be propelled into an earth-encircling orbit. The test was announced at the recent International Astronautical Congress, in Rome, Italy, by a representative of the Glenn L. Martin Company of Baltimore, Md., prime contractors for the launching vehicles.

The launching vehicle, a composite three-stage rocket, will be about 72 feet long. The third stage of the rocket will become a satellite with a velocity of about 18,000 miles per hour. This high speed will be necessary to counteract the earth's gravitational force. It will be attained at the rocket's burnout point, when the fuel is exhausted. At this point the satellite will be nudged ahead by a releasing device activated when the nose

of the rocket opens. Therefore the speed of the satellite will be slightly greater than that of the rocket shell, which will trail after it. The shell is not expected to remain in orbit long because of its "aerodynamically unclean" shape.

The Navy exhibited a model of the satellite during the International Instrument-Automation Conference and Exposition held recently in New York by the Instrument Society of America. The exhibit was a shiny, magnesium alloy globe of about 20 inches in diameter; it had four radio aerials, each about 3 feet in length, and a few tiny windows. The vehicle will weigh about 21 pounds when it is fully loaded. Half of the weight will consist of a radio transmitter and other instruments that have been designed and built by Project Vanguard scientists at the Naval Research Laboratory.

A plastic cut-away model of the satellite's interior showed (i) a 10-milliwatt "minitrack" transmitter that will be used to track the vehicle from ground stations; (ii) pressure, erosion, and temperature gages that will measure space conditions; (iii) a meteorite collision microphone that will detect collisions between the satellite and tiny solid particles; and (iv) "Lyman-Alpha" equipment for measuring the ionization produced by great solar flares on the face of the sun.

Moonwatch Program

The Smithsonian Astrophysical Observatory has announced that the first alert for volunteer artificial satellite observers will be held before the end of the year. On one evening, the date of which will be made public only a few days beforehand, all observing teams will be manning their stations and will be expected to report what they see, if anything, to the observatory at Cambridge, Mass. A study of the reports will help to decide which stations should be designated as strategic. J. Allen Hynek, associate director of the observatory, is in charge of the tracking program, and Armand N. Spitz is coordinator of visual satellite observations.

The volunteer observing program, in which amateur astronomers and other active watchers of the sky are invited to participate, has been designated "Moonwatch." Those selected will have to be on duty approximately three consecutive evenings a month. Anyone interested in volunteering should communicate with the observatory in Cambridge.

The satellite will be observable only in twilight hours, and the first alert will be held in the evening, beginning a few minutes after sunset. The observations will continue until the end of astronomical twilight, 1½ or 2 hours later. Later alerts will be held during morning twilight, so that volunteer observers can become accustomed to reporting to their stations in the middle of the night and continuing to observe until sunrise.

The visual satellite observing program is one of the most valuable single operations in the artificial satellite effort. In order to make the studies of the earth and the atmosphere which have been established as the goal of the project, very accurate measurements of the satellites in orbit must be obtained. These will be made by a series of specially designed telescopic cameras, placed at carefully selected points throughout the world. The cameras must be directed to the area where the satellite can be found. They are not designed to do the finding but rather to make extremely precise measurements of the satellite's position and motion, very small changes in which will provide the data required for the scientific studies. Those operating the telescopic cameras must have knowledge of the orbit in advance so that the instruments can be trained on the correct region of the sky.

In the early days of any satellite in orbit it is expected that data will be obtained from the radio devices developed for this purpose by the Naval Research Laboratory. However, the radio in a satellite will not last more than 2 or 3 weeks, and the only way to be sure that the satellite is not lost is to rely on Moonwatch volunteers. These nonprofessional observers will send information to Cambridge; there the data will be fed to computers to produce a predicted orbit. With this knowledge, the special satellite telescopes can be aimed for effective use.

There are already about 35 stations in the Moonwatch program, and it is hoped that eventually there will be several times this many. The first station was set up in Silver Spring, Md. It was built at the home of G. R. Wright, chairman of the National Advisory Committee for Visual Satellite Observations.

A number of observing teams have gained the support of civic-minded business and professional organizations in establishing their satellite stations. In Phoenix, Ariz., the station will be located on the top of the skyscraper building of the Valley National Bank. Carl Bimson, president of the bank, has announced that the entire cost of building, equipping, and maintaining the Moonwatch program would be borne by the bank as a public service.

At Sacramento, Calif., members of the Institute of Navigation at Mather Air Force Base have declared their intention to set up and equip a satellite station. In Denver the Moonwatch activities will be sponsored by the Denver Museum of Natural History. In St. Louis, H. C. Grigg, president of the 7-Up Company, has announced that he will construct a complete station on the roof of his building and will equip the Moonwatch team with whatever they require for their observing program.

The basic equipment for a station includes a 25- to 35-foot pole and crosspiece to serve as a meridian marker, a radio, a tape recorder, and a very simple telescope. The brightness of the satellite will range from scarcely naked-eye visibility to between 8th and 9th magnitude, averaging about magnitude 7.

Radio Signals from Mars

The Navy has announced the first detection of radio waves from Mars. They were picked up with a 600-inch radiotelescope at the Naval Research Laboratory in Washington, D.C., by the same team that earlier this year detected radio emissions from Venus.

The radio emissions that were recorded from Mars indicate that the planet's average temperature is slightly lower than the freezing point of water. The signals, which were picked up on two clear nights in the week of 9 Sept. when Mars was at a point nearest the earth, were measured at a wave length of 3 centimeters.

Blood Velocity in the Aorta

A method for measuring, in animals, the velocity with which blood is ejected at a given instant from the heart into the aorta has been developed at the National Heart Institute, National Institutes of Health, Bethesda, Md., by Donald L. Fry, Alexander J. Mallos, and Alfred G. Casper of the Clinic of General Medicine and Experimental Therapeutics. This advance, which will soon be applied to human beings, may make it possible for scientists to calculate the power output of the heart and from this to judge the reserve power of the hearts of both normal persons and heart patients.

The new technique, which measures blood velocity in the aorta itself, is known as "a catheter tip method for the measurement of instantaneous aortic blood velocity." A detailed description of the work appeared in the September issue of *Circulation Research*.

Global Flight to Determine the Earth's Magnetic Field

A world-circling scientific expedition, directed by the Air Research and Development Command to determine more accurately the shape of the earth's magnetic field, took off recently in a Boeing KC-97 from L. G. Hanscom Field in Bedford, Mass. The expedition was a joint under-

taking of the ARDC, the Strategic Air Command (SAC), and the University of Chicago. The global flight was proposed by John A. Simpson and Peter Meyer of the Enrico Fermi Institute for Nuclear Studies.

With scientists of ARDC's Air Force Cambridge Research Center accompanying a selected crew from SAC's Second Air Force, the KC-97 flew a 1500-pound cosmic-ray meter on the 90,000-mile trip in order to measure the intensity of cosmic rays at the equator. From these measurements the shape of the magnetic field, far out from the earth's surface, will be determined.

Assumptions regarding the pattern of the magnetic field above the ionosphere have been based on measurements made on the surface of the earth. Heretofore it has been assumed that this pattern projected outward into space substantially as it existed on earth. Studies of cosmic rays, however, which are influenced by the earth's magnetic field as far out in space as 4000 miles, have given definite indication that the magnetic field is "twisted" and has a pattern that varies from the previous assumption. The measurements obtained during the special flight are expected to permit fairly accurate mapping of the outer magnetic equator. The information gained is expected to be of great help to many agencies who will be using geophysical data during the forthcoming International Geophysical Year.

Effort to Determine the Amount of Matter in Space

A group of investigators from Stanford University are setting up a radio listening post at the southern tip of South America in a new attempt to learn more about conditions in outer space. Ernst Gehrels, a graduate student in Stanford's Radio Propagation Laboratory, has gone to Punta Arenas, Chile, where he will install and operate the receiving equipment. Robert A. Helliwell, a member of the technical panel on ionospheric physics for the International Geophysical Year, is directing the project with support from the Office of Naval Research.

Gehrels will attempt to detect specific signals from the Navy's radio transmitter at Annapolis, Md. These will be commonly used low-frequency signals of around 20 kilocycles, ordinarily reflected back to earth by the ionosphere some 60 miles aloft. Gehrels will be located as near as possible to the point of a signal's return to earth from its take-off point at Annapolis.

The Stanford group's theory is that some of this signal energy penetrates the ionosphere and escapes into outer space. But when there is sufficient ionized matter in space, the escaping signal energy is believed to come under control of the earth's magnetic field, which focuses it and gradually bends it back toward earth. The signal's looping path through space is estimated to be 40,000 miles long and to rise 15,000 miles above the earth. The Stanford experiment may lead to a better estimate of the amount of matter in space.

Varying Incidence of Heart Disease

The Public Health Service has reported wide variations in mortality rates from coronary heart disease in different parts of the United States, with rates twice as high in some states as in others. A survey has been made that is an initial step in a nationwide study of variations in the incidence of heart disease. The survey is described by Philip E. Enterline and William H. Stewart in the 20 Sept. issue of *Public Health Reports,* Public Health Service journal.

Improved methods of reporting causes of death, which became effective in 1949, and population data from the national census of 1950 have provided information for a more accurate study of coronary heart disease rates than has been previously possible. The recent study showed that coronary heart disease causes about a third of all deaths among white males in the age group 45 to 74, and about a fifth among men 35 to 44. The rates among white females were somewhat lower. The lowest death rate for coronary heart disease among white males of all ages in 1950 was in New Mexico, 191.1 per 100,000 population. Arkansas had a rate of 201.2 and Kentucky 211.2.

Rates for white males were highest in New York, Rhode Island, and the District of Columbia (Washington, D.C.): 393.8, 364.3, and 344.3 per 100,000, respectively. For white females the differences in death rates from coronary heart disease in different areas were even greater—83.4, 87.8, and 89.0 in New Mexico, Arizona, and Nebraska, as compared with 217.4, 176.6, and 175.6 in New York, New Jersey, and Rhode Island.

News Briefs

■ The Radiological Institute of Freiburg University, Freiburg, Germany, has reported that the level of radioactivity detected in some grain fields and pastures increased during July and August and reached a level that, if maintained, would be dangerous to human beings. The radioactivity was particularly serious on high ground, and at about 4000 feet it was 10 times as strong as in the valleys. The radioactivity of milk from cows grazing on the heights in the Black Forest was about 5 times as strong as that from cows in the plains.

■ A long-distance call to London by Cleo F. Craig, president of American Telephone and Telegraph Company, inaugurated the world's first transoceanic telephone cable system on 25 Sept. Ceremonies were held in New York, London, and Ottawa. Construction of the phone link, which can carry up to 36 conversations simultaneously, was undertaken 2 years ago by A. T. and T., the British Post Office, and the Canadian Overseas Telecommunication Corporation. The principal underwater section of the system crosses the Atlantic between Clarenville, Newfoundland, and Oban, Scotland.

■ The U.S. Atomic Energy Commission has announced that it proposes to waive its statutory rights to inventions or discoveries resulting from the use of certain materials made generally available by the commission. Notice of the proposed policy and of the materials involved appeared in the *Federal Register* for 18 Sept. The published notice gives opportunity to the public to comment within 30 days after the date of publication.

■ Ground was broken last month for Canada's first nuclear power plant, which will be the plant at Des Joachims on the Ottawa River about 20 miles north of the present atomic research plant at Chalk River. The $15-million installation will have a capacity of about 20,000 kilowatts by 1958. It is not expected to produce power at an economically competitive cost, but it is designed to give scientists an opportunity to learn how to do so.

Scientists in the News

THOMAS F. GALLAGHER of the Sloan–Kettering Institute for Cancer Research delivered the first of the New York Academy of Medicine's Harvey Society lectures. He discussed "Steroid hormone production and metabolism in man." Other lectures have been scheduled as follows: 11 Oct., DAVID BODIAN of Johns Hopkins University, "Physiologic aspects of infectious processes in poliomyelitis"; 15 Nov., ERWIN CHARGAFF, professor of biochemistry at Columbia University, "Of nucleic acids and nucleoproteins"; 20 Dec., FRANCIS D. MOORE, Mosely professor of surgery at Harvard University and surgeon-in-chief for Peter Bent Brigham Hospital, "Metabolism in trauma; the meaning of definitive surgery"; 17 Jan., A. M. PAPPENHEIMER, Jr., professor of microbiology at New York University College of Medicine, "Hypersensitivity of the de-

layed type"; 21 Feb., STANFORD MOORE and WILLIAM H. STEIN of the Rockefeller Institute for Medical Research, "Determination of the structure of proteins; studies on ribonuclease"; 21 Mar., P. B. MEDAWAR, professor of zoology at University College, University of London, "The immunology of transplantation"; 11 Apr., DAVID E. GREEN, professor of enzyme chemistry at the Institute for Enzyme Research, University of Wisconsin, "Studies on organized enzyme systems"; 16 May, THOMAS H. WELLER and RICHARD P. STRONG, professor of tropical public health at Harvard School of Public Health, "Observations on the behavior of certain viruses that produce intranuclear inclusion bodies in man"; 6 June, CARL J. WIGGERS of the Bunts Educational Institute, Cleveland Clinic, "Harvey tercentenary."

The American Heart Association has named the winners of the annual Howard W. Blakeslee awards for outstanding reporting in the field of heart disease. The winners will receive their awards, which include a $500 honorarium, at the AHA annual dinner that is to be held in Cincinnati, Ohio, on 28 Oct., during the association's annual meeting and scientific sessions, 26 Oct.–2 Nov.

The Science Department, *Life* magazine, is to receive an award for a ten-page pictorial article explaining coronary thrombosis, illustrating the various stages of recovery, and presenting advances in research, diagnosis, and treatment. The individual winners are as follows:

FRANK CAREY, science reporter, Associated Press, Washington, D.C., for his year-round news coverage of developments in cardiovascular research, treatment, and prevention.

NATE HASELTINE, science writer, Washington Post and Times Herald, for his series of six newspaper articles entitled, "Within a Child's Heart," covering heart disease in childhood, including advances in heart surgery and in the prevention and treatment of rheumatic fever.

ROBERT P. GOLDMAN, science editor and assistant managing editor, *Parade* magazine, for his series of articles presenting new developments in research and treatment of rheumatic and congenital heart disease, coronary artery disease, and hypertension.

HOWARD WHITMAN, medical commentator on the NBC television network's "Home Show," for a series of four programs entitled "Your Heart," covering the young cardiac, high blood pressure, heart surgery, and the function of the heart, filmed at centers in Philadelphia, Boston, and New York.

GEORGE VOUTSAS, producer-director, and EARL HAMNER, writer, for the radio program, "Courage to Live," broadcast by the NBC radio network as one of the "Biographies in Sound" series. This hour-long program presents the documentary story of a patient who faces the decision to undergo heart surgery.

PAUL D. WHITE, a special Blakeslee citation for what was described as "the outstanding service which he performed in creating better public understanding of problems of heart disease through his press conferences, published articles and radio and television appearances during the illness and recovery of President Eisenhower."

THORNTON C. FRY, assistant to the president of Bell Telephone Laboratories, retired on 1 Oct. after completing more than 40 years of service. A mathematician well known in both academic and industrial circles, Fry has held many distinguished posts at Bell Laboratories, including director of mathematical research, director of switching research, and director of switching research and engineering. He has served as assistant to the president since 1949.

Fry was graduated from Findlay College in 1912 and later received a Ph.D. degree in mathematics from the University of Wisconsin. He joined the Bell System in 1916 and since then has been continuously associated with its research and development activities.

There were few professional mathematicians in industry in 1916, and Fry was a pioneer in defining their role in industrial research. He organized the Bell Laboratories mathematical research department. He is best known as an expert on the mathematical theory of probability, and especially its application to various communication problems. He is the author of a book on this subject, *Probability and Its Engineering Uses*. In the future, Fry plans to engage in consulting work.

H. W. NIEDHARDT, formerly pathologist for the Baptist Hospital, Beaumont, Tex., has been appointed associate pathologist at the M. D. Anderson Hospital and Tumor Institute, Houston, Tex. This appointment also carries with it the title of associate professor in the University of Texas postgraduate division.

MASSOUD SIMNAD, who has been a staff member in the Metals Research Laboratory at Carnegie Institute of Technology since 1949, has joined the General Atomic Division of the General Dynamics Corporation, San Diego, Calif. A naturalized American citizen who was born in Iran, Simnad received his Ph.D. in physical chemistry (metallurgy) from Cambridge University (England) in 1945.

HARVEY W. LANCE has rejoined the staff of the National Bureau of Standards as chief of the Calibration Center that is now under construction at the NBS Boulder Laboratories. Formerly head of microwave systems research at the Naval Ordnance Laboratory in Corona, Calif., Lance's immediate duties will concern securing equipment and personnel for the center as well as preparing general plans for operation. The center has the status of a section in the organizational structure of the Boulder Laboratories.

EDGAR C. BRITTON, director of the Edgar C. Britton Research Laboratory of the Dow Chemical Company, Midland, Mich., has received the 1956 Perkin medal of the American Section, Society of Chemical Industry.

CHARLES F. KETTERING, inventor and General Motors research consultant, is the first recipient of a medal named in his honor that is being sponsored by the American Institute of Electrical Engineers. The general concept of the new award, subject to later refinement, is to recognize from time to time those who have made creative contributions through discovery, invention, or improvements in designs or processes.

Seven scientists will be honored by the American Society for Metals during its 38th National Metal Exposition and Congress in Cleveland, Ohio, 8–12 Oct.

EDGAR H. DIX, JR., assistant director of research at the Aluminum Company of America's Aluminum Research Laboratories in Pittsburgh, Pa., will be presented with the Albert Sauveur achievement award for his outstanding work in aluminum alloys research.

WILLIAM H. EISENMAN, for more than 39 years national secretary of the society's headquarters in Cleveland, will receive the ASM gold medal. The citation describes Eisenman as a man who "advanced metallurgy from an art to a science" while helping build the society to its present membership of more than 27,000 members in 100 chapters around the world.

CHARLES M. WHITE, recently elevated from the presidency to the board chairmanship of the Republic Steel Corporation, will be given the ASM research medal for his consistent sponsorship of metallurgical research and development. Under White's leadership, Republic Steel in recent years has been in the forefront of stainless steels and titanium research.

ERNEST P. NIPPES, professor of

metallurgy at Rensselaer Polytechnic Institute, will be given the ASM's teaching award for his outstanding performance in the teaching of technical men.

Three scientists share the ASM Henry Marion Howe medal award for their joint paper on "Delayed failure and hydrogen embrittlement in steel": ALEXANDER R. TROIANO, professor and head of the department of metallurgy at Case Institute of Technology; WILLIAM J. BARNETT, former Case research associate now with the General Electric Company at Evendale, Ohio; and RICHARD P. FROHMBERG, also a former Case research associate, now a senior engineer with the North American Aviation Corporation, Downey, Calif.

SYLVAN I. COHEN has joined Olin Mathieson Chemical Corporation as an agricultural research specialist in the research and development department of the Insecticides Division at Port Jefferson, N.Y. He was formerly vice president for research of Gallowhur Chemical Corporation, Ossining, N.Y. Much of his work has concerned the development of mercurial seed disinfectants and other new organic foliage fungicides. He holds patents on several compounds developed for use in this field.

LESTER GUTTMAN, who from 1946 until 1955 was a member of the faculty at the University of Chicago, has been named to the metallurgy and ceramics research department of the General Electric Research Laboratory, Schenectady, N.Y. Prior to joining the G.E. staff, he spent a year in Harwell, England, studying neutron diffraction.

Recent Deaths

BERNARD V. CHRISTENSEN, Columbus, Ohio; 71; retired dean of the College of Pharmacy of Ohio State University; 13 Sept.

ALICE DUNBAR, Somerset, Md.; 77; one of the first women chemists in Government service; 8 Sept.

WILLIAM A. D. EVANS, Summit, N.J.; 75; electrical engineer; retired executive of the General Electric Company; 13 Sept.

IDA V. GIBSON, Ithaca, N.Y.; associate professor of food and nutrition at Cornell University; 16 Sept.

JOHN I. HAMAKER, Lynchburg, Va.; 86; biology professor emeritus of Randolph-Macon Woman's College; 24 July.

HARRY L. HOLLINGWORTH, Montrose, N.Y.; 76; professor emeritus of psychology and founder and former head of the department at Barnard College; 17 Sept.

BERNARD D. JUDOVICH, Philadelphia, Pa.; 52; associate professor at the Graduate School of Medicine of the University of Pennsylvania; founder and head of the Pain Research Foundation of the Graduate Hospital; 13 Sept.

CHARLES K. LEITH, Washington, D.C., and Madison, Wis.; 81; emeritus professor of geology at the University of Wisconsin; vice president of AAAS Section E in 1919; consultant to the foreign minerals division of the Atomic Energy Commission; 13 Sept.

JAMES P. PORTER, Swarthmore, Pa.; 82; retired editor of The *Journal of Applied Psychology*; former head of the department of psychology at Ohio University; 14 Sept.

HENRY B. SAFFORD, Garden City, L.I., N.Y.; 72; professor of gynecology and obstetrics at New York Medical College; 16 Sept.

Education

■ The Ford Foundation has announced the allocation of grants totaling $21,750,000 to strengthen instruction in the 44 privately supported medical schools now in operation in the United States. The grants are in the amount of $500,000 to each of 43 4-year institutions and $250,000 to the 2-year medical school at Dartmouth College. They were authorized by the foundation's board of trustees upon the recommendations of a special advisory committee headed by Lee DuBridge, president of the California Institute of Technology. The advisory committee was set up by the foundation to develop plans for distributing the $90 million that the foundation appropriated last December to aid the instructional programs of the private medical schools.

The grants are to be held by the recipient institutions as invested endowment for at least 10 years. During this time the income from the endowment may be expended for instructional purposes. Excluded from purposes of the grants are construction and research needs. After a 10-year period the medical schools will be free to use the principal sum as well as endowment income. In announcing the 44 grants the foundation indicated that it expects to disburse the balance of the $90-million appropriation during the current academic year.

■ The Office of Education is now accepting applications from American elementary, secondary, and junior college teachers who wish to teach abroad under the United States International Educational Exchange Program during the school year 1957–58. Three hundred awards will be made available by the Board of Foreign Scholarships.

To qualify for an award under this program, a candidate must be a United States citizen, have a bachelor's degree, and a minimum of 3 years of successful teaching experience. The deadline for receipt of applications is *15 Oct.* Requests for the bulletin, *Teacher Exchange Opportunities, 1957–58,* and application forms should be addressed to the Teacher Exchange Section, Office of Education, U.S. Department of Health, Education, and Welfare, Washington 25, D.C.

■ The Atomic Energy Commission, Oak Ridge National Laboratory, and the Oak Ridge Institute of Nuclear Studies have announced that 102 scientists from Oak Ridge laboratories will be available on request to lecture, conduct seminars, and participate in colloquia at university campuses throughout the country. This arrangement is made possible through the Oak Ridge Traveling Lecture Program, which is being presented for the ninth consecutive academic year.

A brochure has just been issued on the program for 1956–57; it lists the speakers who will participate and names some 165 different lecture subjects. Ninety of this year's lecturers are from ORNL, two represent the University of Tennessee–AEC Agricultural Research Program; three are with the ORINS, and seven are members of the AEC staff at Oak Ridge. Additional information and brochures may be obtained by writing the chairman, University Relations Division, Oak Ridge Institute of Nuclear Studies, Box 117, Oak Ridge, Tenn.

■ In an effort to meet its increasing demand for high-caliber technical graduates, the National Bureau of Standards is giving students an opportunity to become acquainted with a government research laboratory during their undergraduate summers and to discover the advantages of a professional career at the bureau. Open to physical science and engineering majors and also to selected high-school graduates who have displayed unusual scientific ability, the Student Trainee Program is proving mutually beneficial to the bureau and the trainees. Approximately 150 students have been employed annually since the program was initiated in 1948. Besides carrying their share of the work load during the summer, many fulfill the ultimate aim of the program and later return to the staff in a permanent capacity.

To gain eligibility on the register from which appointments to the program are made, college men and women must pass a written Civil Service examination for student trainees. At the high-school level a limited number of direct appointments are offered to winners in the Westinghouse Science Talent Search and other science competitions. A student who has taken part in the program and is recommended by his supervisor may return

each summer while he is completing his education. Participating in the program at the Washington laboratories for the first time this summer were 92 students, from 50 colleges, and 15 Science Talent winners. Of last year's 148 summer scientists, 80 returned to work this summer. At the laboratory in Boulder, Colo., where the program has just been adopted, 42 trainees were employed.

Salaries are commensurate with the educational level of the applicant, starting at $2690 per year for high-school graduates entering at the GS-1 level and progressing to $3415 for GS-4 employees who have completed the junior year in college. Graduates who return to the bureau receive a GS-5 rating, $4480, and those who are employed in a permanent capacity are advanced to GS-7, $5335, after 3 months if they have qualified under a special training agreement during the preceding summer. Graduate students are also accepted for summer employment, a master's degree qualifying scientists or engineers for a GS-7; those who have completed half the required work for a Ph.D. are rated at GS-9 and receive $6250.

Grants, Fellowships, and Awards

■ The National Vitamin Foundation in the period from 1946 to 1955 has made grants for research work in the field of nutrition totaling more than $1 million. The foundation's annual report, which has just been released, discloses that during 1955 alone, appropriations in support of research and for scientific and medical educational purposes amounted to $185,079. The report shows that medical investigation supported by the foundation is helping to open new avenues of treatment in such widely diverse conditions as obesity, emotional stress, cancer, pregnancy, chemical poisoning, and diseases of the aged.

Grants-in-aid of research and fellowships have been given for work in institutions located in 24 states and the District of Columbia, and in four foreign countries. Six states, California, Illinois, New York, Ohio, Pennsylvania, and Tennessee, received more than $50,000 each and together received 73 percent of the research funds granted to 24 states. The same six states contain approximately 52 percent of the population of the 24 states receiving grants, which in turn account for about 72 percent of the total population of the United States.

As part of its scientific program the foundation conducted, in cooperation with leading hospitals and universities, three major scientific meetings: A symposium on the antimetabolites, their modes of action, and therapeutic implications was held in New York; a symposium on the role of some of the newer vitamins in human metabolism and nutrition was held in cooperation with Vanderbilt University School of Medicine in Nashville, Tenn.; and a clinical symposium on nutritional and metabolic considerations in disease was held in Philadelphia, Pa., in cooperation with the commissions on nutrition of the Medical Society of Pennsylvania and the Philadelphia County Medical Society. In addition to these activities, the foundation has carried on an extensive scientific publication program.

■ The U.S. Atomic Energy Commission has announced the award of 88 unclassified physical research contracts with universities and private research institutions. Twenty-five are new contracts, and the remainder are renewals.

■ The Council of the Food and Agriculture Organization of the United Nations has decided to commemorate André Mayer, its first president and one of the founders of the organization, by creating a number of fellowships to be known as the André Mayer FAO senior research fellowships. The fellowships will be awarded yearly to experienced research workers, particularly from technically underdeveloped countries, so that they may enhance the welfare of their countries by traveling to appropriate centers of learning to conduct research in nutrition, agriculture, and agricultural economics.

■ The department of meteorology at Florida State University has announced the availability of graduate assistantships for the academic year 1957–58. Any candidate for the M.S. or Ph.D. degree in meteorology and climatology is eligible to apply. No previous meteorological education is necessary, but the applicant's undergraduate education must have included at least a year of the calculus and a year of university-level physics.

A graduate assistantship carries a stipend of $1740 per calendar year for students holding a bachelor's degree and $2040 for students holding a master's degree in meteorology. The student is permitted to carry ten semester hours of formal course work. Assistants pay resident fees (for health service, student activities, and so forth) of about $75 per semester. Out-of-state tuition is waived. Cost of room and food is approximately $900 per year for single students.

Primary research fields are synoptic meteorology, theoretical meteorology, tropical meteorology, and climatology from the analytic point of view. Applications should be filed before *15 Apr. 1957*. However, later applications will be considered if funds are available. For further information, write to Dr. Werner A. Baum, Head, Department of Meteorology, Florida State University, Tallahassee, Fla.

■ The Federal Government, through its various programs for the support of higher education, in 1954 aided more than one out of every six undergraduates in all fields of study. Nearly 390,000 undergraduate, graduate, and postdoctoral students were supported by the Government at an average cost per student of more than $1000. Of this number, more than 101,000 were preparing for careers in the sciences, including the social sciences.

These data are contained in a report entitled *Federal Support for Science Students in Higher Education* that has been released by the National Science Foundation.

The percentage of Government-supported students studying the sciences increased with the educational level. While only one-fourth (82,000) of the undergraduate group were studying in the sciences, approximately half (18,000) of the graduate students and virtually all (1300) of those receiving such assistance for postdoctoral training and research were pursuing scientific studies.

Eligibility for Federal support at the undergraduate level was determined almost exclusively by military service, either through the completion of past service or through commitment to future service. With the exception of nearly 6500 students holding 4-year scholarships awarded under the Navy's "Holloway Plan," nearly all of the 345,000 federally aided undergraduates in all fields of study were veterans of the Korean conflict receiving educational benefits under Public Law 550 enacted by Congress in 1952.

More than one out of every three students receiving Federal aid for graduate study in the sciences was employed as a research assistant on research grants or contracts awarded by Federal agencies to senior investigators at colleges and universities. Veterans' educational benefits provided support to more than a quarter of all federally aided graduate students.

In addition to these large-scale programs, four Federal agencies awarded fellowships to a select group of 1600 young men and women for graduate study, about half of whom were embarking upon science careers. These agencies, namely, the Atomic Energy Commission, the National Science Foundation, the National Institutes of Health, and the Department of State, also awarded more than 600 fellowships for postdoctoral training and research in the sciences. A copy of *Federal Support for Science Students in Higher Education* may be obtained for 30 cents from the Superintendent of Documents, Washington 25, D.C.

Reports

Radiocarbon Dates of Mankato Drift in Minnesota

The town of Mankato on the Minnesota River in south-central Minnesota is the type locality for the deposits of the Mankato substage of the Wisconsin glacial stage. The surface drift in this area was deposited by the Des Moines lobe of the Keewatin ice sheet, according to Leverett (*1*). Recent work by Ruhe and Gould (*2*) has shown that at least the outer part of the Des Moines-lobe drift is Cary, rather than Mankato, in age, and investigations by Wright (*3*) near Minneapolis indicate that at least some of the drift of the Grantsburg sublobe of the Des Moines lobe is also Cary in age. On the other hand, in northern Minnesota, the St. Louis sublobe of the Des Moines lobe, still presumed to be Mankato in age, seems to have been contemporaneous with the Valders advance of the Superior lobe, implying correlation of Mankato with Valders (*4*).

Certain difficulties in delineating the deposits of Cary and Mankato age in the Des Moines lobe and its Grantsburg sublobe have led to the hypothesis that activities of these ice masses were confined to the Cary glacial substage prior to the Two Creeks interstadial rather than to the Valders advance, which postdates the Two Creeks interstadial. Radiocarbon dates assessed in this report (*5*) strongly support this hypothesis.

The radiocarbon dates pertinent to the age and correlation of the Mankato drift (Table 1) fall into three groups: (i) dates for the Anoka sand plain and Mississippi valley train, which were described by Cooper (*6*) as having formed during and soon after the retreat of the Grantsburg sublobe of Mankato age; (ii) dates for basal organic sediments in lakes on Mankato drift; (iii) dates for the deposits of Lake Agassiz, which was presumed to record the retreat of the Des Moines lobe in Mankato time.

The Anoka sand plain was initiated when the Mississippi River was diverted eastward to the St. Croix River by the Grantsburg sublobe. As the ice margin withdrew to the southwest, the sand plain broadened over the exposed terrain and finally adopted its present relatively straight course from St. Cloud to Minneapolis. The latest outwash episode is represented by the Mississippi valley train, at a level slightly below the Anoka sand plain proper. The valley train has since been terraced by the postglacial Mississippi River.

Peat and wood buried beneath 5 feet of Anoka sand were discovered by R. Farnham in a drainage ditch 3 miles southeast of North Branch, western Chisago County, about 5 miles from the St. Croix River. They represent an early phase in the development of the sand plain, when the Mississippi still flowed east to the St. Croix. The peat (sample W-389) was dated by the U.S. Geological Survey laboratory as 12,700 ± 250 years and the wood (W-354) as 12,030 ± 200 years old.

The Mississippi valley train episode is effectively dated by analyses of material collected in 1923 by W. S. Cooper (*7*) from sand at a depth of 3 to 12 feet in a building excavation at Loring Park, Minneapolis. A piece of wood was dated as 11,790 ± 200 years old (sample W-454) and peat as 10,200 ± 300 years old (sample W-445). The peat date might be the less accurate because of the greater possibility of unseen contamination by modern roots and other intrusions.

Inasmuch as the Two Creeks interstadial at the type locality has been dated many times as about 11,400 Before Present (BP), the North Branch and Loring Park dates suggest that the Anoka sand plain and Mississippi valley train represent wastage of the stagnated Grantsburg sublobe during the Two Creeks interval. This indicates that the Grantsburg sublobe itself is pre-Two Creeks rather than post-Two Creeks in age, as has generally been assumed. Inasmuch as the Grantsburg sublobe had its source to the southwest in the Des Moines lobe, in our opinion the surface drift at the town of Mankato in this direction should also be correlated with the Cary rather than with the Valders.

The physiographic evidence on which Cooper accepted a late Wisconsin (that is, Valders) age for the Anoka sand plain may be reinterpreted in favor of a late Cary age subsequent to the Cary maximum but prior to the Valders advance. The Cary maximum in this area is represented by near-simultaneous advance of ice lobes from both the northeast (Superior lobe) and west (Grantsburg sublobe), and their drifts are interbedded in the area of contact (*3*). The Superior lobe then retreated to the Lake Superior basin. Its meltwater drainageways, directed to and beyond the site of the Mississippi River, were completely abandoned by the time they were overridden by the readvancing Grantsburg sublobe. According to the radiocarbon dates, the Grantsburg readvance (this time all the way to Wisconsin) should be assigned to the late Cary and was matched perhaps by a readvance of the Superior lobe, for which there is some evidence farther north. During the Two Creeks interstadial, the Superior lobe retreated once again, and the Grantsburg sublobe protrusion stagnated, permitting the formation of the Anoka sand plain and the Mississippi valley train.

Terminal dates for Mankato ice cover

Table 1. Radiocarbon dates related to correlation of drift at Mankato, Minnesota. W = Washington, C = Chicago, Y = Yale.

Description	Sample No.	Age (yr BP)
Anoka sand plain and Mississippi valley train		
North Branch, Chisago County. Wood from sand of Anoka sand plain.	W-354	12,030 ± 200
North Branch. Peat from same horizon as W-354.	W-389	12,700 ± 250
Cedar Creek Bog Lake, Isanti County. Gyttja at depth 28 ft, pine-pollen zone B.	C-332	7,988 ± 420
Cedar Creek Bog Lake. Same spot as C-332. Gyttja at depth 30 ft, just above sand.	W-466	11,830 ± 200
Lake on Grantsburg till near Blomford, Isanti County. Basal organic sediment at a depth of 12 ft below water surface.	W-465	4,890 ± 200
Loring Park, Minneapolis. Wood from sand of Mississippi valley train at a depth of 3 to 12 ft.	W-454	11,790 ± 200
Loring Park. Peat from same sand as W-454.	W-445	10,200 ± 300
Lake Agassiz		
Moorhead, Clay County, Minn. Peat from a depth of 45 ft in lake clay.	C-497	11,283 ± 700
Moorhead. Duplicate sample of C-497.	W-388	9,930 ± 280
Rossendale, southern Manitoba. Peat from Lake Agassiz II sediments. Solid carbon analysis.	Y-165	13,230 ± 600
Same as Y-165, by acetylene analysis.		12,400 ± 420
Rossendale. Shell from material correlative with Y-165.	Y-166	11,230 ± 480

in any region may be taken from analysis of basal organic sediments in lakes on Mankato drift. Such dates supply only a minimum age, of course, because many lakes represent buried ice blocks that may have melted out long after disappearance of surface ice. Buried ice blocks of Cary age in this area thus may have survived the Two Creeks interstadial and the Valders cold interval as well. Two lakes (at Cedar Creek Bog and at Blomford) were sampled in an attempt to find a lake that originated immediately after withdrawal of surface ice; the Cedar Creek Bog lake sample is indicative.

Cedar Creek Bog is an ice-block feature in the Anoka sand plain in south-central Isanti County. An earlier sample had been taken by M. Buell from a depth of 28 feet from the pine-pollen zone of Lindeman (*8*) and was dated as 7988 ± 420 years old (sample C-332) (*9*). A new sample, however, collected by F. M. Swain and H. E. Wright from about the same spot at a depth of 30 feet just above the sand at the very base of the organic sediment, yielded at date of 11,830 ± 200 (sample W-466). The result suggests that the lake was already in existence during the Two Creeks interval. This date, in conjunction with the date from the Anoka sand itself at North Branch, only 13 miles to the east, seems to bracket the time of formation of the Anoka sand plain and further supports the late Cary correlation of the drift at Mankato.

The basal organic sediment of a second lake was also analyzed. This lake (near Blomford in central Isanti County) is a ground-moraine lake of the Grantsburg sublobe and should have started its existence very soon after the ice retreat. The date, however, is too late for consideration—4890 ± 200 years (sample W-465).

Glacial Lake Agassiz was initiated when the Des Moines lobe retreated into the Red River valley, which has a normal northward slope (*1*, p. 119). The early outlet was south by way of the Minnesota River valley (Glacial River Warren), but as the ice withdrew to the north it uncovered lower outlets across western Ontario to Lake Superior. Johnston (*10*) and Elson (*11*) have postulated a readvance of the ice to close the eastern outlets and raise the lake level to form Lake Agassiz II.

Whereas Leverett (*1*, p. 119) had considered Lake Agassiz to mark the retreat of the Mankato ice, radiocarbon dates suggest that it was older. Wood studied by Rosendahl (*12*) from a sewer excavation at Moorhead, Minnesota, beneath 25 feet of varved lake deposits (1800 varves) at a depth of about 45 feet below the lake plain was dated as 11,283 ± 700 BP (sample C-497) (*9*). A duplicate sample has recently been reanalyzed in Washington, D.C., as 9930 ± 280 BP (W-388).

Peat collected by Elson from Lake Agassiz II sediments near Rossendale in southern Manitoba was dated as 13,230 ± 600 BP by the solid-carbon method and 12,400 ± 420 BP by the more accurate acetylene method (sample Y-165), and shells from correlative sediment at a nearby locality as 11,230 ± 480 BP (Y-166) (*13*).

The Agassiz dates (except for the rerun of the Moorhead sample) suggest that the lake started its formation before the Valders advance, and even the Moorhead rerun is compatible with this hypothesis. The lake deposits were never overridden by ice in Minnesota, North Dakota, and adjacent southern Manitoba. The Des Moines lobe thus would also predate the Valders. Elson postulates that the Valders ice margin fell along certain moraines that blocked eastern lake outlets in central Manitoba and western Ontario and caused the growth of Lake Agassiz II. There are still difficulties with a Valders border this far north, inasmuch as drift of Valders age in the Superior sublobe and St. Louis sublobe have been identified in Minnesota (*4*), but the Lake Agassiz radiocarbon dates certainly point to a pre-Valders age for the Des Moines lobe proper and thus also for the drift at Mankato.

The radiocarbon analyses discussed in the preceding paragraphs all serve to date the drift at Mankato indirectly. Only one dated specimen of wood has been recovered from the Mankato drift itself. This was collected by R. Schneider from the surface drift near Redwood Falls, 60 miles up the Minnesota River from Mankato, and was dated as > 31,000 years old (sample W-99) (*14*). The drift is believed to be continuous with the surface drift at Mankato, but the date is so much greater than that anticipated for either Cary or Valders time that it must be considered anomalous; the wood may possibly have been derived from older drift. Wood collected by J. H. Zumberge from an oxidized drift that underlies the surface drift at Mankato itself was dated as > 37,000 BP (sample W-300, W-301). This drift must be pre-Wisconsin.

The radiocarbon dates discussed here suggest that the surface drift at Mankato should be correlated with the Cary (pre-Two Creeks) rather than with the Valders (post-Two Creeks). This possibility was discussed by Horberg (*15*) and Flint (*16*). We therefore favor the use of the term *Valders* over the term *Mankato* for the last major substage of the Wisconsin. Adoption of this term would establish the several important intervals of the middle and late Wisconsin—Tazewell, Cary, Two Creeks, and Valders—as units of reference based on the activity of a single ice lobe (Lake Michigan lobe). Most of the stratigraphic and geomorphic relationships can be reconciled to a late Cary correlation for the Grantsburg sublobe, Anoka sand plain, the Des Moines lobe proper, and Lake Agassiz I. The St. Louis sublobe is considered to be Valders in age, but its relationship to Lake Agassiz is not certain at the present time.

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4 September 1956

Structure of Small "Spherical" Viruses

The recent x-ray diffraction study by Caspar (*1*) on a crystal of tomato bushy stunt virus (TBSV) and the electron microscope studies by Williams and Steere (*2*) and by Rice, Kaesberg, and Stahmann (*3*) on frozen-dried preparations of several so-called "spherical" viruses suggest that these particles have a remarkably symmetric structure. The x-ray diffraction study shows that the TBSV particle has twofold and threefold symmetry axes and quite possibly also fivefold axes. The electron microscope studies show that tobacco ringspot virus (TRSV) and squash mosaic virus (SMV) often appear hexagonal in contour and TBSV sometimes appears hexagonal. All of these viruses cast shadows having several straight sides. On the other hand, a polyhedral contour has not been demonstrable previously in frozen-dried preparations of polio virus (*4*) or in turnip yellow mosaic virus (*5*). No detailed electron microscope structure has been reported for any air-dried preparations of small (around 300 A in diameter) viruses, probably because of the distorting effects of surface tension.

Lightly shadowed viruses can be imaged clearly in properly adjusted microscopes, but their shadows are not sufficiently well defined to be very useful. However, *heavy* shadowing with a mate-

rial such as uranium provides sufficient contrast in the shadows, so that they are clearly delineated, although, in this case, the viruses themselves are distorted in appearance. It can be shown from geometric considerations that the metal deposited on the viruses themselves, if it remains fixed where it lands, does not affect the shape of the shadows cast by the viruses.

In this laboratory, frozen-dried preparations of purified turnip yellow mosaic virus, squash mosaic virus, wild cucumber virus, and brome grass mosaic virus have been examined recently (*6*). Lightly shadowed preparations almost invariably suggest a polygonal contour. Hexagonal contours are often seen in the latter three viruses and occasionally in turnip yellow mosaic virus. Figure 1*a* shows three particles of brome grass mosaic virus, each lying in a different orientation with respect to the shadowing direction. The two central particles are clearly hexagonal. The hexagonal contour of the topmost particle is not very evident in the print, particularly because its south-pointing sides are not clearly demarcated. The lower double particle is discussed in a subsequent paragraph. Measurements of the distances between the numerous small bumps on the carbon substrate film show that the microscope can readily resolve 30 A under these experimental conditions.

The shadows of all four preparations usually show four or five straight sides. Figure 2*a* shows particles of turnip yellow mosaic virus which have been shadowed heavily with uranium and printed to a very high contrast. The contrast owing to the uranium is sufficiently high so that only those parts of the viruses on which uranium is deposited are visible. Although the particle images are much distorted and thus do not reveal the true particle contours, it is evident that the shadows are clearly delineated. Such pictures, together with the x-ray and electron microscope work cited here, suggest that these viruses and perhaps all small viruses have approximately the shape of symmetric polyhedrons.

There are only five kinds of polyhedrons that are made up of identically shaped plane faces and vertices in equivalent positions: a tetrahedron (made up of four triangular faces), a cube (six squares), an octahedron (eight triangles), a dodecahedron (12 pentagons), and an icosahedron (20 triangles). The tetrahedron and the cube may be eliminated from consideration, because their contours as viewed from above are clearly at variance with the observed images. Both the octahedron and the icosahedron have hexagonal contours, while the dodecahedron has a ten-sided contour, which might, however, not be resolved clearly in the microscope.

A comparison of the shapes of shadows of the four virus preparations with those that could be produced by the symmetric polyhedrons again unambiguously eliminates the tetrahedron and cube, and also the octahedron, from consideration as suitable models. Shadows cast by the dodecahedron and the icosahedron often can be approximately matched with virus shadows. However, the pointed shadow (the topmost particle in Fig 2*a*), which is sometimes seen, cannot be matched by a dodecahedron lying on any of its faces. Furthermore, a suitably positioned dodecahedron is capable of casting a shadow that is rarely (if ever) seen.

These facts, coupled with the frequency of appearance of hexagonal contours, suggest that these four viruses may have approximately the shape of symmetric icosahedrons. Judging from the particle contours, this approximation is fulfilled best by BGMV and least by TYMV. Figures 1*b* and 2*b* show models of icosohedrons that have been positioned to correspond to the virus particle orientations and show the extent to which agreement can be obtained. It should be emphasized that the heavy shadowing and high-contrast printing in Figure 2*a* preclude any very precise agreement between particle and model contours; the shadow contours should, however, be directly comparable.

Two particles in contact are seen often, particularly with brome grass mosaic virus and turnip yellow mosaic virus. The distance between the extreme ends of such dimers is usually about 20 percent less than twice the particle diameter. Furthermore, it is not possible to get agreement between the shapes of shadows cast by such dimers and the shadows cast by two polyhedrons in contact. Reasonably good agreement is obtained, as is shown in the figures, with a dimer model that consists of two icosahedrons interpenetrating sufficiently to eliminate one corner from each particle and to have five of the corners of one in a common position with five of the corners of the second. It is thus necessary to conclude that these dimers have been very much squashed together at some stage in their preparation or that perhaps they were produced in the plant cells as Siamese twins. Experiments are in progress which are designed to detect and isolate such twins in solution.

It would be desirable if the geometric models considered here could be replaced with more realistic models, perhaps consisting of subunits (*7*) (of protein) surrounding a core (of nucleic acid). In place of the icosahedron, one could, for example, assume a model consisting of identical spherical subunits placed at each of the 12 corners of the icosahedron. This would be a close-packed arrangement, each unit being in contact with five others. (The twins would consist of 17 units, a unit of each

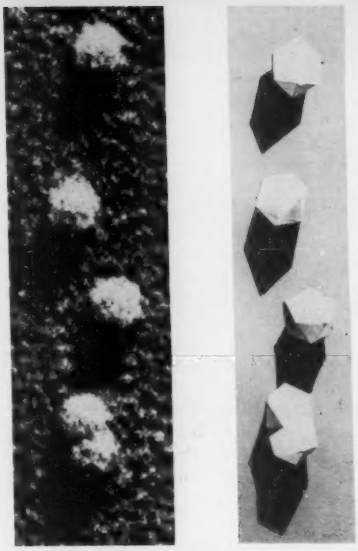

Fig. 1*a* (left). Electron micrograph of lightly shadowed brome grass mosaic virus. Because of the light shadowing, the shadows will not be clearly delineated, but the virus particles themselves should be reproduced faithfully. (× about 240,000.) Fig. 1*b* (right). Icosahedral models of the particles of Fig. 1*a*.

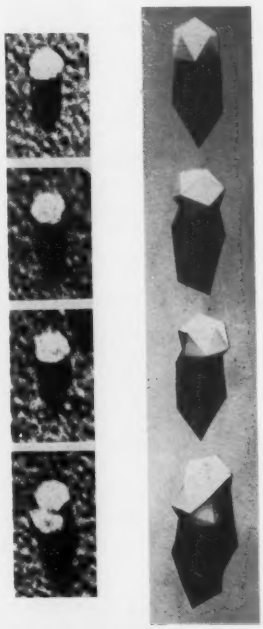

Fig. 2*a* (left). Electron micrographs of heavily shadowed turnip yellow mosaic virus. Because of the heavy shadowing and high contrast printing, the particle contours are much distorted; however, the particle shadows should be clearly delineated. (× about 150,000.) Fig. 2*b* (right). Icosahedral models of the particles of Fig. 2*a*.

twin being absent, and five units being held in common.) However, such a model casts shadows that are in poorer agreement with the virus pictures than does the icosahedron. It would seem necessary to conclude that the subunits are either much larger in number than 12 or are shaped properly to contribute to the icosahedral appearance. Caspar's x-ray data on bushy stunt virus suggest that the most likely number of subunits is 60. His results would be consistent with the electron micrographs if, for example, each of the icosahedral vertices consisted of a cluster of five subunits.

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30 July 1956

Histochemical Evidence of Protein-Bound SH Groups in Plant Tissues with 4-Iodoacetamido-1-naphthol

Dickens (*1*) and Rapkine (*2*) studied inhibition of glycolysis by iodoacetate and iodoacetamide and reported that inhibition was a result of an alkylation reaction with sulfhydryl (SH) groups of reduced glutathione. Young and Conn (*3*) obtained almost complete inhibition of wheat-germ glutathione reductase with iodoacetic acid ($10^{-2}M$) and iodoacetamide ($10^{-3}M$). Barrnett and Seligman (*4*) found complete inhibition of SH staining with 2,2′-dihydroxy-6,6′-dinaphthyl disulfide (DDD) in tissues pretreated with iodoacetate ($0.1M$). However, Barron (*5*) stated that iodoacetate is not SH specific and will react with amino groups of amino acids at a physiological *p*H. Barrnett, Tsou, and Seligman (*6*) reported the results of preliminary histochemical experiments with 4-iodoacetamido-1-naphthol (IAN).

Experiments were conducted with IAN to determine the SH specificity of this reagent in a diazo-coupled reaction in plant tissues. *Zea mays* L. embryos were excised in early stages of germination, when the coleorhiza had initially split the pericarp of the grain. The specimens were fixed for 24 hours in a 2-percent solution of trichloroacetic acid in 80-percent ethyl alcohol. The specimens were dehydrated, imbedded in paraffin, and sectioned at 15 μ. The sections, mounted on slides with albumin, were stained by a modification of the diazo-coupling method of Barrnett and Seligman (*4*) for DDD. In this method, the slides were incubated 2 hours at 60°C in a mixture consisting of 35 ml of Michaelis barbital buffer (*p*H 8.55) plus 15 ml of absolute ethyl alcohol containing 35 mg of 4-iodoacetamido-1-naphthol (*7*). In the coupling reaction the slides were stained in 3 to 5 minutes with tetrazotized diorthoanisidine. Inhibition was achieved by pretreatment of controls for 24 hours in an aqueous solution of N-ethyl maleimide ($0.1M$).

The highest concentration of protein-bound SH was observed in the promeristem of the radicle, and the staining diminished rapidly back from the apex. A high concentration was also observed in the promeristems of the paired adventitious roots located above the level of the scutellar node. Moderate-to-strong staining was observed in the procambial strands throughout the embryo. The embryonic vascular bundles of the epicotyl and coleoptile are similarly stained in cross section. Although the entire embryo is diffusely stained, those areas indicating the least SH include scutellum, coleorhiza, coleoptile, and scutellar node.

The results obtained with IAN are in complete agreement with results that I reported previously (*8*) for TCA-pretreated specimens stained with nitroprusside reagent and Bennett RSR reagent, respectively. Furthermore, I have obtained an identical staining pattern for these tissues with DDD (*9*). We can therefore conclude that the results obtained with this new SH reagent are valid, inasmuch as these findings correspond with results obtained by different types of histochemical reactions (mercaptan, disulfide, and alkylation reactions).

There is, however, the possibility that this reagent may couple with amino groups. Danielli (*10*) has suggested the use of a specific and readily removable NH_2-blocking agent to achieve SH specificity. The Danielli dinitrofluorobenzene method for tyrosine, SH, and NH_2 is based on a series of specific blocking agents. This line of approach has not, in general, been successful (*11*), and I have not used any NH_2-blocking agents with IAN.

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1 June 1956

Odostomia impressa Parasitizing Southern Oysters

Recently Loosanoff (*1*) has reported observations on the pyramidellid snail *Odostomia* (*Menestho*) *bisuturalis* Say as an "obscure oyster enemy" in New England waters. According to Abbott (*2*) and Miner (*3*), *O. bisuturalis* has its southern limit at Delaware Bay. It should now be recorded that *Odostomia* (*Menestho*) *impressa* Say, which ranges from Massachusetts Bay to the Gulf of Mexico, has similar habits. A hundred or more of these snails may be found holding to the extreme margins of an oyster's shell, each inserting its proboscis between the valves whenever the oyster opens to feed. G. Robert Lunz, director of the Bears Bluff Laboratories, demonstrated this to P. Korringa of Holland and myself when we visited South Carolina in 1948. On the very day that Loosanoff's article appeared in *Science*, I arrived at Bears Bluff to begin a long-planned study of this interesting parasite.

Observations and experiments on *Odostomia impressa* to date indicate that its behavior differs somewhat from that of *O. bisuturalis* as described by Loosanoff. Rather than attacking young oysters, like the northern species, *O. impressa* works mostly on large oysters. When numerous snails are placed in the middle of aquaria containing adult oysters at one end and shells covered with spat (3 to 19 mm long) at the other end, the majority of the snails go to the large oysters, and this majority gradually increases as snails desert the spat and collect on the large oysters. Snails placed in an aquarium with single oysters of graded sizes, 26 to 76 mm long, assemble in the largest numbers on the largest oysters and in proportionately smaller numbers on the smaller oysters. Rough surfaces, such as the outside surfaces of oyster shells, attract or retain more snails than smooth surfaces, such as the inside surfaces of oyster shells. Shells of living oysters, bearing many attached snails, lose these snails when the oyster is carefully opened

to remove the meat and then returned to the aquarium, and do not attract any replacements if living oysters are near. Clams (*Mercenaria*) and mussels (*Volsella*), placed in aquaria with *O. impressa* and oysters, do not attract snails; the few that crawl on them do not stay long.

Specimens and records of the Charleston Museum indicate that *O. impressa* is the commonest *Odostomia* in South Carolina; it has been taken from a number of localities by many collectors, starting with Edmund Ravenel prior to 1870. Miner (*3*) and various shell collectors' guides mention that *O. impressa* often occurs on oyster beds. At Bears Bluff, most of the population is found between 1 ft above and 1 ft below mean low-water level. At the beginning of July 1956, the individuals collected ranged from 3.3 to 5.2 mm in height and averaged 4.2 mm. These older snails soon disappeared, and at the end of July they were replaced by a younger group of snails 0.7 to 3.3 mm high, with a mode at 1.5 mm.

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10 August 1956.

Geothermal Survey of Hot Ground Near Lordsburg, New Mexico

In the late fall of 1954, newspapers reported live steam and boiling water issuing from shallow wells being drilled in an area between the Pyramid and the Peloncillo Mountains, 15 miles south-southwest of Lordsburg, N.M. Marx Brook, of the research and development division of the New Mexico Institute of Mining and Technology, made a preliminary examination of the area in December 1954, at which time water samples were collected for analysis. Shortly thereafter it was recommended that a geothermal survey of the area be made.

The locations of three principal wells in the area are shown by solid circles in Fig. 1. These wells penetrate approximately 50 ft of sand and claylike soil underlain by 20 ft of warm-water-bearing gravel. The water-bearing gravel rests on a relatively impervious layer of clay that is approximately 8 ft thick, which in turn covers a hot rhyolite rock. As the drilling operation proceeds through the clay, higher temperatures are encountered, and the water becomes superheated as contact is established with the hot rhyolite.

Two of the three wells were completed at 5 to 10 ft into the rhyolite. One of these behaved like a geyser when it was disturbed by the drilling tools. The third well, which was completed at the upper surface of the rhyolite, can be pumped at the rate of 200 to 300 gal of boiling water per minute.

A geothermal survey was made using resistance thermometers, with the elements installed 1 m below the ground surface. The thermometers were made by installing a thermistor element at the end of a thin (0.25-in. diameter) Bakelite tube, which was subsequently filled with insulating material. Two fine copper wires connect the thermistor to extended leads at the upper end of the tube, where resistance measurements were made with a portable impedance bridge. The thermistor elements at 20°C had a resistance of 18,000 ohm and a sensitivity of approximately 550 ohm per degree centigrade. A hole for receiving the thermometer tube was made by driving a stake 4 ft in length into the ground, and the excess space around the tube was filled with dry sand. This arrangement gave steady-state resistance measurements 30 minutes after installation.

The temperature anomaly is mapped on Fig. 1 with a contour interval of 2°C. Points of temperature observation are indicated by open circles.

The maximum observed temperature at 1 m below the surface was 23°C, approximately 12°C higher than the corresponding readings outside the anomalous region. At one station, a thermistor remained in the ground for 5 days, during which time the air temperature changed from −5°C to +22°C. However, no change in temperature at the 1-m depth was noted during this interval, and in general, during the time of the study, no changes of temperature at this depth were observed. One thermistor has been installed permanently at a depth of 6 m for the purpose of detecting possible changes in ground temperatures at that depth throughout an extended period.

Temperature readings were taken at both 1- and 2-m depths at three locations in the warmest area, and a mean vertical gradient of 10°C/m was determined. Calculations based on a reasonable value of the heat conductivity of the earth material and the observed temperature gradient indicate a power flow of approximately 7500 kw for the area enclosed by the 18°C cohtour line.

Ranchers of the neighborhood have noticed that the winter snows melt almost immediately over an area approximately 0.5 mile in diameter in the neighborhood of the wells. Distinct changes occur in vegetation at the edges of the thermal anomaly. This is especially striking toward the south end of the area, where the temperature contour lines are close together. On the southeast, creosote bushes begin to grow where the anomaly ends. On the southwest, the hot area cuts through a cotton field. Over the hot area, the cotton stalks grow only 6 in. tall, whereas off the anomaly they attain a height of about 2 ft. Aerial photographs show the outline of the hot region as revealed by changes in vegetation at the edges.

Three hypotheses might explain the origin of the heat: (i) Hot steam and vapors, ascending from great depth along faults and fractures, are the source of heat. (ii) A postrhyolite and relatively recent intrusive has been emplaced beneath the rhyolite and is the source of heat. (iii) The rhyolite is itself the heat source. Since, however, the rhyolite, if correlated with similar rhyolites in adjacent areas, is probably of mid- to late-Tertiary age, it is highly improbable that its original heat could be retained.

It is possible that further study will indicate the true heat source. In the meantime, it would appear desirable to employ modern core-drilling methods, using compressed air, for the purpose of drilling deeper into the rhyolite mass for more significant temperature measurements.

Because of the high thermal gradient, an attempt was made to detect possible potential differences generated by the differential movement of ions in an electrolyte subject to a temperature gradient (Soret effect). Ground potentials owing

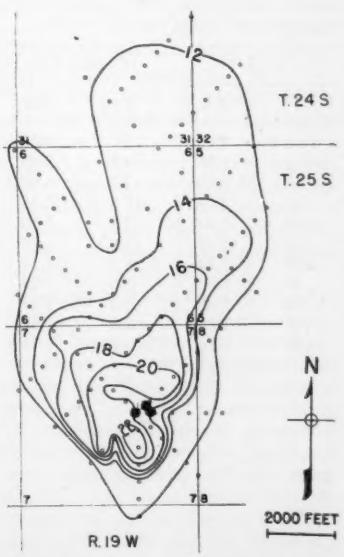

Fig. 1. Geothermal map. Temperature 1 m below surface; contour interval 2°C.

to local variations in soil composition and other sources were too large, however, to permit the recognition of such potential differences.

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23 April 1956

Dahllite Identified as a Constituent of Prodissoconch I of Pinctada martensii (Dunker)

Werner (*1*) reported that prodissoconchs (larval shells) of *Mytilus edulis* L., *Macoma baltica* L., *Zirphaea crispata* L., and other species are composed of two parts, prodissoconch I (prod. I), and prodissoconch II (prod. II), named by him, respectively.

Prodissoconch I is the shell that is formed prior to the D-shaped stage. It has radial stripes composed of many fine spots, but it has no concentric growth rings. Prodissoconch II is the shell that is formed around prod. I during the free-swimming stage. Prodissoconch II is markedly distinguished from prod. I by its concentric growth rings.

I found (*2*), in addition, similar configurations in the prodissoconchs of *Pinctada martensii* (Dunker) obtained by artificial fertilization after the method of Kobayashi and Yuki (*3*). About 7 hours after fertilization, fertilized eggs develop into post-trochophores. At the end of this stage (about 20 hours after fertilization), vellum appears, and prod. I begins to develop in accordance with the formation of the shell gland. In about 4 hours, prod. I develops into the D-shaped form. Thereafter, the formation of prod. II takes place. This shell continues to grow until the settled stage is reached. The appearance and growth of prod. II correspond to those of the mantle. It is therefore conceivable that prod. I is formed from the shell gland, and prod. II from the mantle.

Table 1. Electron diffraction data for prod. I of *Pinctada martensii* (Dunker) compared with x-ray data for dahllite.

Prod. I		Dahllite (*6*)	
I	d A	I	d A
S	3.73	2	3.75
vvW	3.36	1.5	3.34
W	3.05	1.5	3.02
m	2.74	10	2.72
vvW	2.64	1	2.60
vW	2.23	2	2.24
vvW	2.11	0.5	2.11
W	1.93	2.5	1.93
vvW	1.86	1.5	1.87
vW	1.84	2.5	1.83
vvW	1.70	0.5	1.71

Werner ascertained the calcification of both prod. I and prod. II, but no report has appeared concerned with the constituents of prod. I or prod. II. For this reason, I tried to identify these under a polarizing microscope (*4*).

Both prod. I and prod. II are soluble in HCl and HNO_3. Prodissoconch II is colorless and uniaxial negative with very strong birefringence. The refractive indices are $N_O = 1.659$ and $N_E = 1.484$, respectively. Hence, the inorganic part of prod. II is shown to be composed of calcite crystals. In contrast, prod. I is pale green in color and uniaxial negative with very weak birefringence, showing dark gray color under crossed nicols. These characters indicate that crystals of prod. I apparently differ from those of prod. II. The refractive indices are $N_O = 1.633$ and $N_E = 1.612$, respectively. These indices approximately coincide with the Winchels' value (*5*) for dahllite, with 53 mole percent of podolite and 47 mole percent of hydroxyapatite. Therefore, the inorganic component of prod. I must be considered to be dahllite rather than calcite.

For more complete verification, the crystalline form of prod. I and its electron diffraction patterns have recently been examined. (For these purposes, prod. I was not so finely powdered as in the ordinary method, and photographs were taken with a newly built Hitachi superhigh-voltage electron microscope at 200 kv.) The lattice spacings that were calculated from the diffraction patterns agreed fairly well with figures for dahllite given by Roseberry *et al.* (*6*) (see Table 1). With these results dahllite is identified as a constituent of prod. I of *Pinctada martensii*.

It is known that mineral components of bones or teeth of vertebrates are hydroxyapatite (or dahllite according to McConnell, *7*), but the existence of dahllite in shells has never been reported. Although shells or pearls contain tricalcium phosphate (Shimizu, *8*, Tanaka and Hatano, *9*, and Stolkowski, *10*), only a trace is present. The mechanism of the dahllite formation has not yet been studied, but a future study is planned.

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13 December 1955

Correction

In the article "Radiosensitivity factors in oat seeds: dormancy, water and development" [*Science* 123, 1125 (22 June 1956)], the journal in reference 4 is incorrectly given as *Bot. Rev.*; it should be *Bot. Gazette.*

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Correction

It has been brought to our attention that we did not designate the correct collectors of several of the samples reported in "Lamont radiocarbon measurements III" [*Science* 124, 154 (27 July 1956)]. The following list gives the proper collectors for several samples in Table 4 under *V. Arctic studies*: L192B, R. D. Cotell (1952); L261A,B,C, G. Hattersley-Smith (1953); L254A, L248A, R. L. Christie (1954); L254B,C,D, E. W. Marshall (1954); and L248B, G. Hattersley-Smith and A. P. Crary (1954).

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Book Reviews

Science and Civilisation in China. vol. 2, *History of Scientific Thought.* Joseph Needham. Wang Ling, research assistant. Cambridge University Press, New York, 1956. 696 pp. Illus. $14.50.

With the appearance of this *History of Scientific Thought* (in China), Needham launches the second volume of his formidable undertaking of a seven-volume history of *Science and Civilisation in China.* Inasmuch as each volume constitutes a relatively independent unit, it seems appropriate to emphasize its subtitle in calling attention to this second volume.

The temporal span of Chinese science, as presented here, runs approximately from the time of Confucious until the merging of Chinese science into "the world-wide unity of modern science" in the 17th century. This is almost exactly the same period covered by a standard history of Chinese philosophy, such as the recently published *Short History of Chinese Philosophy* by Fung Yu-Lan. The significance of this apparent parallel rise and fall of Chinese philosophy and scientific thought is not clearly elucidated by Needham, but when it is added to the fact that the characters in the two histories are nearly identical, it emphasizes the close and continuous dependence of Chinese science on philosophy. Scientific thought is obviously closely related to philosophy in other cultures, and certainly in Europe, but in Europe the degree of that interrelationship has waxed and waned, and some of the greatest exponents of scientific thought have been indifferent philosophers, to say the least. One receives the impression from this book that no comparable waxing and waning occurred in China. When the philosophers ceased to interest themselves in scientific thought, scientific thought itself ceased.

There is some question whether this is the impression that Needham intends to give, for he frequently makes allusion to the debilitating effect on Chinese scientific thought of the prejudice of philosophers against working with their hands, and seems to suggest that there were other Chinese thinkers who did not have this prejudice. These suggestions consist, however, of references to later (and still unpublished) parts of his work, which will deal with the specific sciences and technology. Insofar as we can learn from the present work, these handworkers participated very little in the development of scientific thought.

On the other hand, it seems to be on the basis of the evidence of these handworkers that Needham frequently states that Chinese scientific thought in various areas was equal to or greater than contemporary thought in the West, and his general conclusion seems to be that Chinese thought was in advance of the West until the Western "scientific revolution" of the 17th century. That he fails to produce a clear exposition of the relationship of technology to scientific thought is a weakness of the book, but an understandable one, since it remains to be accomplished in the relatively better known area of Western science. Unfortunately it is somewhat exaggerated by Needham's insistence on the importance of this relationship that he fails to describe.

Needham concludes that the Chinese world-view depended on "a totally different line of thought" from that in the West. This conclusion is reached at the end of a long and impressively worked out chapter on the influence of the development of theories of the laws of nature on legal thinking and legal systems in the two cultures. Here, and elsewhere, he emphasizes the organic character of the Chinese world-view. He makes little use of that favorite term of historians of European science, *vitalism,* and his approach appears refreshingly original in comparison with the tendency of many writers on the history of science to view the subject in a framework of mechanism versus vitalism. A factor that aids him greatly in avoiding this framework is the apparent unimportance of mathematical thinking to the Chinese world-view. This is surprising in view of the opinion which has been commonly held of late that Chinese work in mathematics was considerable, and we may hope that Needham will cast light on this in a subsequent volume. Meanwhile, although he does not declare with any emphasis that mathematical thinking had little influence on Chinese scientific thought, he certainly does not give it a very significant role. This, above all else, gives the book a different character from that of any modern history of scientific thought in Europe.

Regardless of what criticisms may be made of various aspects of Needham's work, this volume, like its predecessor, exhibits a breadth of learning and a concern for the apparatus of scholarship, which makes it not only a monumental work in its field, but also an indispensable guide for future students in this field. All in all, the book raises more questions than it answers, but this is to the credit of the author, for the study of Chinese science in the West has scarcely been advanced heretofore to the point where one knew what the questions are. More would be unreasonable to expect of an author whose labors have laid all Sinologists and historians of science in his debt. It is also worth noting that he provides a guide to the essential portions of the book, for the "busy experimentalist" who does not have time to read it all.

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Biology of the Laboratory Mouse. Staff of the Roscoe B. Jackson Memorial Laboratory. George D. Snell, Ed. Dover, New York, 1956. viii + 497 pp. Illus. $6.

This is a new printing, unabridged and unaltered, of the first edition, which was published in 1941 by the Blakiston Company and has been out of print for some time. The rationale for this book is stated clearly by the editor, George D. Snell, in the preface: "Of all the laboratory mammals, probably none has contributed more to the advancement of knowledge than the common mouse. . . . A result of this extensive use of the mouse is that a large body of information has grown up concerning it. This, however, is so widely scattered through the literature that it is often a major undertaking for the research worker who wishes to use it to locate and gather the particular facts that he needs. Much of this information is assembled in this book."

The subject matter is divided into 13 chapters of which all but one were contributed by members of the laboratory: one chapter each on embryology, reproduction, and histology; six chapters on genetics and/or tumor formation (gene and chromosome mutations, genetics of spontaneous tumor formation, genetics of tumor transplantation, endocrine secretion and tumor formation, and the milk influence in tumor formation); four chapters on general subjects (inbred and hybrid animals, parasites, infectious diseases, and care and recording). The scope of the book is limited of necessity

and the emphasis is on "established facts useful to the research worker."

In the past 15 years the mouse has been even more extensively used in research in genetics, bacteriology, endocrinology, and cancer and in radiation studies. Great advances have been made in some of these fields and an impressive array of new data has accumulated. The question then arises whether it was worth while to reprint this book without revision. The answer is in the affirmative.

It would certainly have been desirable to have several of the chapters brought up to date, but, as it stands, this book still contains a body of basic, useful information, and it deserves a place on the reference shelf in any laboratory that uses rodents as research animals.

DOROTHY PRICE

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Hormones and the Aging Process. Proceedings of a conference held at Arden House, Harriman, N.Y., 1955. Earl T. Engle and Gregory Pincus, Eds. Academic Press, New York, 1956. 323 pp. Illus. $8.50.

This is a book that is much more important than its size. As a matter of fact, this is one of the most informative books ever written on hormones and aging. The list of contributors reads very much like a "Who's Who in Endocrinology," and their contributions are important to this increasingly complex subject. The editors were most judicious in selecting their participants, and they have edited the present volume in a very scholarly manner. There are many, perhaps too many, books compiled on a whole array of subjects, but it is my opinion that *Hormones and the Aging Process* will long remain a leader in its field. The combined basic and clinical approach bridges the gap from theory to practice.

This book is heavily endowed with information that is both interesting and cleverly presented. The rich academic flavor of Arden House is obvious throughout the 18 chapters that comprise this volume: "Aging and urinary steroid excretion" (G. Pincus), "Effect of aging on the steroid metabolism as reflected in plasma levels" (L. T. Samuels), "The thyroid in the aging process" (R. W. Rawson), "Urinary excretion of gonadotropin as a function of age" (A. Albert, R. V. Randall, R. A. Smith, and C. E. Johnson), "Hormonal regulation of muscle development" (C. D. Kochakian and Carol Tillotson), "Steroids and protein metabolism in experimental animals" (J. H. Leathem), "Androgenic and anabolic action of testosterone derivatives" (V. A. Drill and F. J. Saunders), "Naturally occurring pathology in the aging rat" (D. J. Ingle), "Effects of hormones on protein metabolism" (A. White), "The role of steroids in calcium and phosphorus metabolism" (O. H. Pearson), "Newer techniques in the study of calcium metabolism in man and effects of hormones thereon" (D. Laszlo and Herta Spencer), "Mechanisms regulating fluid and electrolyte metabolism" (R. E. Weston), "Steroid hormones in osteoporosis" (G. D. Whedon), "Sex steroid replacement in the aging individual" (W. H. Masters), "Effects of steroids in women with breast cancer" (B. J. Kennedy), "Endocrine regulation of prostatic growth" (H. Brendler), "The effects of some of the steroid hormones on the metabolic balances in aged males" (N. W. Shock), and "Cerebral metabolism in the aging process: the steroid factor" (G. S. Gordon and J. E. Adams, with the technical assistance of E. Martinez).

Of particular interest to me are the following chapters. In his chapter on "Aging and urinary steroid function," Pincus has developed the opening chapter with the wisdom and intellectual know-how of a seasoned teacher. His last paragraph is certainly indicative of a crowning achievement: "We are confronted with two similar findings: that aging and certain chronic stress conditions tend to diminish the output of certain urinary steroids. The simple conclusion would be that in aged persons the decrement is the effect of the cumulative stresses of living. In states of chronic stress this effect is telescoped. If this suggestion is warranted many questions arise. First of all, is this effect true of all chronic stress states? If so, what does the chronic stress, or the aging process, in fact do to steroidogenic mechanisms? In the case of adrenocortical steroid production impairment may be due to damage in the adrenal cortex or to impairment of adrenocorticotropin production. We have elsewhere published data indicating that in schizophrenic subjects there is an impairment of certain ACTH-stimulated adrenocortical steroidogenic processes. This impairment appears to persist into old age in schizophrenics. Normal, healthy old men do not show this defective response to ACTH. It thus follows that the reduced steroidogenesis in the normal aging may be the result of reduced ACTH production by the pituitary. What are the factors controlling pituitary production of ACTH? Which are age-labile? These and related questions are open to experimental investigations. . . . With care and patience we may emerge with a coordinated scheme of certain aspects of endocrine function in youth and old age."

In the chapter on "Urinary excretion of gonadotropin as a function of age," Albert and his associates have summarized and extended the original observations from their laboratory in the Mayo Clinic and Mayo Foundation. Their data indicate that children of both sexes, below the age of puberty, do not excrete detectable urinary gonadotropin. In premenopausal women there is a progressive and fourfold rise in urinary gonadotropin between the ages of 10 and 50 years. These values seem to increase progressively after the menopause, and the urinary gonadotropins attain a peak value 15 to 19 years following cessation of the menses but then fall progressively throughout the next 20 years. In men a demonstrable, although slight, increase in urinary gonadotropin occurs as a function of age, but this increase is less than half of that of women at the ages of 10 to 49 years, and only a fifth of that of women over the comparable age span of 50 through 89 years. (Hisaw will be proud of his young disciple at the Mayo Clinic, especially since this is the finest study of its kind yet recorded along with the observations of Bahn *et al.*, also emanating from Albert's laboratory.)

In "Androgenic and anabolic action of testosterone derivatives," Drill and Saunders have produced a scholarly group of experiments, and their chapter is one of the most interesting and outstanding ever written on this subject. It is clearly obvious that the chalk dust has never left the fingers of these two champions of clarity, conciseness, and pedagogy at its best. No tacit assumptions are made here. In comparing the anabolic and androgenic effects of testosterone (and its propionate) with those of 19 nortestosterone (and its derivatives), they have found that (i) all of these androgens produce nitrogen retention in rats on a constant food intake; (ii) all the nor-compounds studied have a better anabolic androgenic ratio than testosterone, testosterone propionate, methyl testosterone, methylandrostenediol, and androstanolone; (iii) at minimal effective intramuscular doses, 19 nortestosterone, 17-methyl-19-nortestosterone, and 17 ethyl-19-nortestosterone are equally potent in increasing levator ani weight; and (iv) above the minimal effective dose, 17-ethyl-19-nortestosterone, administered intramuscularly, produces the greatest effect on levator ani weight. Substitution of the methyl, propyl, butyl, ethynyl, or vinyl radicals for the ethyl radical reduces anabolic potency, even though a favorable anabolic and androgenic ratio is maintained. These scientists have a thorough grasp of their subject matter and have pursued it most extensively.

In "Naturally occurring pathology in the aging rat," D. J. Ingle's modesty is outflanked by his careful analysis of con-

ditions leading to naturally occurring pathologies in aging rats. His systematic approach reveals that (i) 100 percent of the rats that were more than 12 to 15 months old developed tumors of the mammary glands, (ii) 97 percent of the rats had gross changes in the aortas representing calcifying atherosclerosis, (iii) 46 percent had pitting in the kidneys caused in part by the dilation of the tubules at the surface, (iv) ulcers of the cardiac portion of the stomach were observed in 25 percent, and (v) 90 percent had adrenal glands that were spotted and granular. Ingle's discussion of "Adaptation diseases, adaptation energy and recommendations for further research" graphically illustrates both his scientific storehouse of information and his ability to single out important facets that lend themselves to crystallization.

The zenith of intellectual endeavor reaches a spire of meaning in "Sex steroid replacement in the aging individual" through the efforts of W. H. Masters. The discussion of a third sex will be received as both stimulating and provocative, depending, of course, on the age of the reader.

This book is recommended without any reservations. Here is a book that will make everyone appreciate more thoroughly the physiological process of aging that lies ahead in each of our careers.

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Gmelins Handbuch der Anorganischen Chemie. System No. 60. *Copper.* pt. A, sec. 1. Edited by Gmelin Institute under the direction of E. H. E. Pietsch. Verlag Chemie, Weinheim/Bergstrasse, ed. 8, 1955. 710 pp. Illus. $92.85.

Gmelins Handbuch der Anorganischen Chemie. System No. 60. *Copper.* pt. A, sec. 2. Edited by Gmelin Institute. Verlag Chemie, Weinheim/Bergstrasse, ed. 8, 1955. 755 pp. Illus. $101.04.

This volume, as do the others in this excellent reference series, impresses the reader with its thoroughness and with the breadth of its coverage of the topic. It is stated that the literature through 1949 has been completely examined and in certain instances through 1954. The table of contents is highly detailed. At the beginning of the sections on many of the major topics, lists of general references are given. These general references are not confined to German treatises but include works from a number of different nations.

The style in which the German text is written is clear and easily readable. There are numerous tables and diagrams which help to clarify the text, and the quality of printing and reproduction is excellent. This work is a must for any chemistry library and would be particularly valuable to inorganic chemists, metallurgists, and geologists with an interest in copper or copper ores and minerals.

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Proceedings of the Conference on Pathophysiologic and Therapeutic Problems of Terminal Conditions Associated with the Clinic and Practice of First Aid. State Publishing House of Medical Literature, Moscow, U.S.S.R., 1954. 240 pp. Illus. (In Russian).

The deliberations of this conference were centered primarily around the methods of revival of organisms developed by V. A. Negovskii, director of the Laboratory of Experimental Physiology of the U.S.S.R. Academy of Medical Sciences in Moscow. The discussions were related to problems of restoration of physiologic functions in animals and patients in agonal states and in early stages of clinical death resulting from severe hemorrhage, burns, drowning, electrocution, and so on. Under consideration also were methods of combating late stages of traumatic and burn shock.

Most of the resuscitation techniques reported at the conference involved (in addition to artificial respiration) the utilization of "antidromic" intra-arterial infusions (that is, directed toward the heart) of blood (usually oxygenated) and, at times, of various physiologic salt solutions. The quantities of blood thus infused (under a pressure of 160 to 220 mm-Hg) were comparatively small: 150 to 500 ml, usually the lower figures. Following the restoration of cardiovascular functions, intravenous infusions were resorted to when more blood or a blood substitute was needed.

The history of intra-arterial infusions goes back to at least 1871–74, when two Russian physicians, S. I. Kostaev and S. P. Kolomnin reported intra-arterial administration of defibrinated blood into patients with severe traumatic episodes. F. A. Andreev, in 1913, initiated experimental investigations of this method, continuing his experiments until shortly before his death in 1952. Extensive experimental and clinical observations were made by V. A. Negovskii *et al.* and many others. According to Negovskii's figures, arterial infusions were made in 1714 patients, 797 of whom (46.5 percent) survived. Of the 1714 patients thus treated, 1190 were in severe shock, not responding to other forms of therapy, and 57 percent of these survived; 227 were in agonal states and 45 percent of these survived; 116 were in a state of clinical death and 18 percent of these survived.

Briefly, the principle of the method is based on restoration of coronary blood flow and the alleged stimulation of cardiovascular interoceptors, thus leading to reflex stimulation of the cardiovascular system. A fair amount of basic experimental data is presented but not enough to satisfy the curiosity of a physiologist, at least not mine. The bulk of the emphasis was on clinical observations.

Interesting experiments are reported by E. A. Asratyan (Moscow). He produced controlled cerebral anoxia by raising the cerebrospinal fluid pressure to 300–400 mm-Hg in dogs kept alive by artificial respiration. Although the results obtained may be due also to mechanical pressure, the data are still of interest to clinicians and physiologists. Many of the animals remained alive for months even after 16 to 20 minutes of cerebral anoxia. The author reports four phases of restoration: (i) restoration of bulbar and spinal centers; (ii) phase of overexcitation and hyperthermia, at times resembling the state of decerebrate rigidity (the use of central nervous system depressants during this phase appeared to improve the chances of survival; this phase may last for hours or even days and may alternate with periods of calmness); (iii) phase of depression which may last several hours to many weeks; (iv) slow restoration of central nervous system functions.

The speed and degree of restoration of function depended on the length of the period of anoxia, age, and "constitution" of the dog. Thus, after a period of anoxia lasting 16 to 20 minutes, the dogs were able to sit up after 3 to 4 months and to stand after 6 months or even after a longer period. After an anoxic period of 8 to 10 minutes, sitting was possible after 4 to 6 days and standing after 10 to 15 days. Sensation was affected earlier and for a longer period than motor functions.

Conditioned reflexes (motor defense responses) disappear even after 5 to 6 minutes of anoxia but can soon be fully restored. After an anoxic episode of 6 to 8 minutes the conditioned reflexes disappear for longer periods and are not fully restored; ability to differentiate decreases. The conditioned responses are inconstant but, peculiarly enough, are difficult to extinguish. Following a period of anoxia lasting 8 to 12 minutes, conditioned reflexes disappear even for a longer period, differentiation is never restored, the conditioned reflexes are in-

constant and are even more difficult to extinguish. The central nervous system thus appears to have lost its "plasticity." After periods of anoxia lasting 16 to 20 minutes, conditioned reflexes are never restored.

E. M. Smirenskaya, from Negovskii's laboratory, presented some noteworthy data that suggest the importance of the stimulation of vascular interoceptors (by means of arterial infusions) in the restoration of cardiovascular activity in dogs after clinical death from hemorrhage. She utilized Novocain injections into various parts of the cardiovascular system as a means of blocking the interoceptors. Electrocardiographic studies indicated that stimulation of these interoceptors in any part of the arterial tree may lead to increased electric activity of the heart. Under conditions of anoxia, such stimulation (for example, dissecting out an artery without local anesthesia) may lead to fibrillation. This point may bear further investigation.

T. T. Shcherbakova and M. K. Martsinkevich, from Bryukhonenko's laboratory, reported on their experiments on dogs, using an "autojector," a pump that delivers oxygenated blood into an artery (not antidromically, but in the normal direction of blood flow) and removes blood for oxygenation from any peripheral vein. They claimed that their dogs could be revived even after a period of clinical death lasting for as long as 24 minutes and that these dogs remained normal for years. These claims were received with some skepticism by most of the other participants of the conference. Bryukhonenko himself (a noted surgeon) was not present at the conference, although he was invited. He was criticized for his failure to report detailed descriptions of his method and of his experimental results.

F. F. Svidler (Odessa) reported on his method of artificial respiration involving electric stimulation of the phrenic nerve in cats and dogs, including the stimulation of motor points in the region of the neck.

I. P. Petrov and E. V. Gubler (Leningrad) presented some data on the effect of central nervous system depressants and of hypothermia on survival after exposure to various periods of cerebral anoxia. Soporific doses of central nervous system depressants had a beneficial effect, while larger doses had a deleterious effect. Hypothermia was beneficial. There appeared to be some potentiation between hypothermia and soporifics. These results were interpreted in terms of I. P. Pavlov's concept of "protective inhibition" of the central nervous system.

There was considerable disagreement among the members of the conference on whether the arterial infusions should be rhythmic or continuous. It was argued by some that rhythmic infusions are more likely to produce effective stimulation of the vascular interoceptors, but no convincing data were presented.

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New Books

High Energy Nuclear Physics, Proceedings of the Sixth Annual Rochester Conference. 3–7 Apr. 1956. Compiled and edited by J. Ballam, V. L. Fitch, T. Fulton, K. Huang, R. R. Rau, S. B. Treiman. Interscience, New York, 1956. $3.75.

The Earth beneath Us. H. H. Swinnerton. Little, Brown, Boston, American ed. 1, 1956. 335 pp. $5.

Clay and Clay Minerals. Proceedings of the Third National Conference on Clays and Clay Minerals. Publ. 395. National Academy of Sciences–National Research Council, Washington, 1955. 573 pp. $7.

Grasslands of the Great Plains. Their nature and use. J. E. Weaver and F. W. Albertson. Johnsen, Lincoln, Neb., 1956. 395 pp. $6.50.

The Training of Sanitary Engineers. Schools and programs in Europe and in the United States. Milivoj Petrik. World Health Organization, Geneva, 1956 (order from Columbia University Press, New York). 151 pp. $4.

Sleep. Marie C. Stopes. Philosophical Library, New York, 1956. 154 pp. $3.

Applied Electrical Measurements. Isaac F. Kinnard. Wiley, New York; Chapman & Hall, London, 1956. 600 pp. $15.

Handbuch Der Physik. vol. XXII, *Gas Discharges.* S. Flugge, Ed. Springer, Berlin, 1956. 652 pp. DM. 128.

Chemistry of High Polymer Degradation Processes. Norman Grassie. Interscience, New York; Butterworths, London, 1956. 335 pp. $6.50.

How to Make and Use a Telescope. H. Percy Wilkins and Patrick Moore. Norton, New York, 1956. 196 pp. $2.95.

Introductory Psychosomatic Dentistry. John H. Manhold, Jr. Appleton-Century-Crofts, New York, 1956. 193 pp.

The Image. Kenneth E. Boulding. University of Michigan Press, Ann Arbor, 1956. 175 pp. $3.75.

Chemistry of Carbon Compounds. vol. III, pt. B, *Aromatic Compounds.* E. H. Rodd, Ed. Elsevier, Amsterdam–Princeton, 1956 (order from Van Nostrand, Princeton, N.J.). 1669 pp. $25.

Textbook of Biophysical Chemistry. Edward S. West. Macmillan, New York, ed. 2, 1956. 399 pp. $7.

Statistical Mechanics, Principles and Selected Applications. Terrell L. Hill. McGraw-Hill, New York, 1956. 432 pp. $9.

Bird and Butterfly Mysteries. The truth about migration. Bernard Acworth. Philosophical Library, New York, 1956. 303 pp. $7.50.

Polyethylene. vol. XI of *High Polymers.* R. A. V. Raff and J. B. Allison. Interscience, New York, 1956. 551 pp. $16.

Corn and Its Early Fathers. Henry A. Wallace and William L. Brown. Michigan State University Press, East Lansing, 1956. 134 pp. $3.75.

William Heytesbury, Medieval logic and the rise of mathematical physics. Curtis Wilson. University of Wisconsin Press, Madison, 1956. 219 pp. $4.

The New Outline of Modern Knowledge. Alan Pryce-Jones, Ed. Simon and Schuster, New York, 1956. 624 pp. $6.

Supersonic Inlet Diffusers and Introduction to Internal Aerodynamics. Rudolf Hermann. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., 1956. 378 pp. $16.

High Pressure Technology. Edward W. Comings. McGraw-Hill, New York, 1956. 572 pp. $11.50.

Latex, Natural and Synthetic. Philip G. Cook. Reinhold, New York; Chapman & Hall, London, 1956. 231 pp. $3.50.

Perspectives in Organic Chemistry. Alexander Todd, Ed. Interscience, New York, 1956. 527 pp. $7.50.

Magnetochemistry. Pierce W. Selwood. Interscience, New York, ed. 2, 1956. 435 pp. $11.50.

The Condensed Chemical Dictionary. Arthur and Elizabeth Rose. Reinhold, New York and Chapman & Hall, London, ed. 5, 1956. 1201 pp. $12.50.

Observations on Krebiozen in the Management of Cancer. A. C. Ivy, John F. Pick, W. F. P. Phillips. Regnery, Chicago, 1956. 88 pp. $2.50.

The Chemistry of the Coordination Compounds. John C. Bailar, Jr., Ed. Reinhold, New York; Chapman & Hall, London, 1956. 834 pp. $18.50.

The International Dictionary of Physics and Electronics. Walter C. Michels, Ed. Van Nostrand, Princeton, N.J.; Macmillan, London, 1956. 1004 pp. $20.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Lectures on Orthopaedics and the Rheumatic Diseases. Scientific Conferences, 29 Sept.–1 Oct. 1955, held in connection with dedication of the new building of The Hospital for Special Surgery, New York City. Marguerite Clark, Ed. Hospital for Special Surgery, New York, N.Y., 1956. 182 pp.

Symposium on the Management of Tuberculosis. Journal of The Mount Sinai Hospital, New York, vol. XXIII, No. 4. The Hospital, New York, N.Y., 1956. 325 pp. $2.50.

The National Aeronautical Collection. Smithsonian Institution National Air Museum. Paul E. Garber. Smithsonian Institution, Washington, ed. 9, 1956. 166 pp.

Bernice P. Bishop Museum, Annual Report for 1955. A museum is a point of view. Alexander Spoehr. Bishop Museum Press, Honolulu, Hawaii, 1956.

Index of Taxonomic Specialists in Entomology. N. D. Riley. International Union of Biological Sciences, Entomology Section, British Museum, London, 1956. 37 pp.

Meetings and Societies

Physics of Semiconductor Surfaces

Semiconductor surfaces have been the subject of intensive research during the past 5 years because of their intrinsic interest and because they affect the performance of transistors and other semiconductor devices. Progress during recent years was reviewed, and new results were reported, at a Conference on the Physics of Semiconductor Surfaces that was sponsored jointly by the Office of Naval Research, the University of Pennsylvania, and the Lincoln Laboratory of Massachusetts Institute of Technology. The conference was held at the University of Pennsylvania in Philadelphia, 4–6 June 1956. The cochairmen, representing the aforementioned groups, were J. L. Jackson, P. H. Miller, and R. H. Kingston, respectively. Approximately 125 attended, including nine from overseas. While the majority of the participants were physicists, the chemists were well represented and took an active part in the conference. As P. B. Weisz stated in his introductory talk on the subject of adsorption and catalysis, the chemist's approach to surfaces has been mainly through studying the effect of metal and semiconductor surfaces on gas reactions, while the physicist's approach has emphasized the influence of gas ambients on the properties of the solid. It was generally agreed that the conference succeeded in enlightening each group about the other's point of view.

Detailed proceedings of the conference are being published by the University of Pennsylvania Press. This report is intended to be only a summary, but if it is read in connection with a recently published review article [R. H. Kingston, *J. Appl. Phys.* **27**, 101 (1956)] it should convey a reasonably up-to-date picture of the field.

The subject matter and chairmen of the sessions were as follows: "Clean surfaces," J. Bardeen (University of Illinois); "Real surfaces—fast states," H. K. Henisch (University of Reading, United Kingdom); "Real surfaces—slow states," A. F. Gibson (Radar Research Establishment, United Kingdom); "Adsorption and catalysis," P. Aigrain (Ecole Normale Superieure, France); and "Surface oxidation," W. H. Brattain (Bell Telephone Laboratories).

C. Herring (Bell Telephone Laboratories) opened the conference with a review of the theory of surface states. He classified them into states associated with an ideal crystal plane (Tamm and Shockley states) and states associated with isolated surface imperfections. He discussed the density, energy level, capture cross-section, donor or acceptor character, and excited levels of these states. This provided an excellent starting point because the main emphasis of the conference was on surface states.

Since the work of Tamm in 1932, it has been expected that the surface of an ideal crystal would have a high density (10^{15} per square centimeter) of surface states. However, it is difficult to prepare an ideal surface and to keep it clean while making measurements. Low-energy electron diffraction patterns of a germanium surface that is prepared by a high-temperature bakeout show an amorphous structure. In 1954, H. E. Farnsworth, R. E. Schlier, and R. M. Burger (Brown University) prepared germanium surfaces by bombarding with ions of argon and then annealing in high vacuum. These surfaces show a diffraction pattern with all the lines to be expected from a germanium surface. In addition, a set of ½-order lines are present which cannot be attributed to normal germanium sites. R. E. Schlier reported the most recent experimental work of the group and suggested that the extra lines are due to the displacement of germanium surface atoms. This displacement permits the atoms to saturate their bonds. An alternative explanation, offered from the floor, is that there is a half-monolayer of oxygen on the surface. Evidence for this is that a small amount of oxygen admitted to the system changes the diffraction pattern, but subsequent heating at 500°C restores the pattern to its original condition. It is argued that the binding energy of the first half-monolayer of oxygen is much too large for it to be driven off at 500°C; thus, a half-monolayer must have been present before the test oxygen was admitted.

P. Handler (University of Illinois) reviewed recent work at the University of Illinois, Brown University, Harvard University, and Lincoln Laboratory on the electric properties of germanium surfaces prepared by the ion-bombardment technique. From work-function, surface-conductance, field-effect, and photoconductance measurements, a strong case was argued that the states observed were Tamm-Shockley states. This conclusion, however, was not accepted unanimously by those at the conference. Perhaps the most serious objection was the afore-mentioned oxygen reversibility.

R. H. Kingston concluded the morning session with a short review of the important milestones in the study of semiconductor surfaces. (See his review, the aforecited article, for references and discussion.)

The model of a germanium surface which was the basis for the discussion of real surfaces is shown in Fig. 1. The case of a p-type surface on an n-type crystal has been shown. The space-charge region can be n- or p-type, depending on the gas ambient, temperature, etch, and so forth. If the space-charge region and crystal are of opposite type, the surface is said to have an inversion layer as shown in Fig. 1. If they are of the same type and the concentration in the space-charge region is greater than it is in the interior, the surface has an accumulation layer; if the carrier concentration on the surface is less than in the crystal, it is called a depletion layer. Conduction is assumed to take place in the space-charge region but not in the oxide layer.

Two general classes of states, interface and outer, are shown in Fig. 1. Electrons and holes make transitions into, and out of, the interface states in times of the order of microseconds to milliseconds, while the times involved for transitions to and from the outer states are of the order of seconds to minutes.

J. R. Schrieffer (University of Illinois) opened the first of the sessions on real surfaces by reviewing and presenting new results of his theory of mobility in the space-charge region. This theory predicts a reduction in mobility of carriers in surface channels due to scattering from the surface. The theory has been confirmed indirectly by field-effect and conductance measurements, but a direct measurement of the surface mobility has not yet been made.

A. Many, E. Harnik, and Y. Margoninski (Hebrew University, Israel) reported measurements of the surface recombination velocity, s, in germanium. This quantity is a meaure of the rate at which electrons and holes recombine at the surface, presumably through the interface states. Transverse electric fields were used to vary the height of the surface potential, and consequently s. The results indicate that, in some samples, the

Shockley-Read theory with one type of recombination state at the surface describes the data adequately. Other surfaces exhibit a more complex structure, involving two types of states. Analysis of the data shows that the surface states are acceptorlike in both *n*- and *p*-type material.

B. H. Schultz (Philips Research Laboratories, Netherlands) reported a theoretical study of storage of injected carriers in surface channels. He concluded that, in low resistivity materials ($\rho < 1$ ohm-cm), measurements of the relaxation time for recombination in thin rods are not suitable for the determination of the surface recombination velocity, unless one takes precautions against surface storage effects.

The field-effect measurement has proved to be useful in studying surface states. An electric field is applied capacitively to the surface, inducing a change in the density of carriers and a measurable change in conductance. A portion of the induced charge is rapidly immobilized in interface states, after which quasi-equilibrium exists for times of the order of seconds to minutes, when further charge is immobilized in the outer states.

P. C. Banbury, G. G. E. Low, and J. D. Nixon (University of Reading, United Kingdom) described field-effect experiments on accumulation-type surfaces of germanium in which the initial decay was studied. From analysis of the data, they find the cross-section for majority carrier capture in interface states to be 10^{-17} to 10^{-16} square centimeter in both *n*- and *p*-type material.

W. L. Brown, W. H. Brattain, C. G. B. Garrett, and H. C. Montgomery (Bell Telephone Laboratories) reported field-effect experiments on etched germanium surfaces at frequencies such that quasi-equilibrium with the fast states existed. From analysis of this and capacitance data, the density of interface states is found to be 10^{11} to 10^{12} per square centimeter, per volt near the middle of the band, and somewhat larger at 0.1 electron volt above and below the band center. From analysis of surface photovoltage and surface recombination-velocity measurements, they find the states are acceptors with capture cross-sections of 6×10^{-15} square centimeter and 4×10^{-17} square centimeter for holes and electrons, respectively.

Another important tool in the study of surfaces is the channel effect on transistors. A channel occurs, for example, when a *p*-type surface develops on the *n* region of a *p-n-p* transistor, resulting in an inversion layer as shown in Fig. 1. It is a deleterious result as far as transistor action is concerned because the conductance of the transistor is then mainly due to the surface channel. Such a system, however, provides a sensitive method of studying inversion layers. H. Statz, G. A. de Mars, L. Davis, Jr., and A. Adams, Jr. (Raytheon Manufacturing Company) reported such measurements on silicon and germanium. They find in silicon an interface density of 10^{12} states per square centimeter about 0.45 electron volt below the middle of the gap and another set of density 10^{11} to 10^{12} per square centimeter varying in position between 0.42 and 0.48 electron volt above the middle of the gap. Their results for germanium are similar to those reported by other contributors.

Charge transfer into, and out of, the slow outer states represented in Fig. 1 can be induced by electric fields (d-c field effect) and by light. Such experiments on germanium show that the time decay associated with slow states does not follow a simple exponential law. S. R. Morrison (Minneapolis-Honeywell Corporation) reviewed two methods of interpreting such data, a multiple time-constant system which would result from an inhomogeneous surface, and the Elovitch equation where the transition rates depend on the instantaneous surface potential. He concluded that a combination of the two models is needed to fit the data.

M. Lasser, C. Wysocki, and B. Bernstein (Philco Corporation) reported that the dependence of the slow time constant on the thickness of the oxide layer indicates that the slow states are on the outside of the layer. The time constant shortened appreciably when the dry air ambient was replaced by water vapor.

J. Zemel (Naval Ordnance Laboratory) reported that for lead sulfide films the slow field effect could be described by a single time constant of the order of 10 minutes.

Measurements of slow changes in the work function of gold, germanium, and silicon induced by light and electrostatic fields were reported by G. W. Pratt, Jr., and H. H. Kolm (Lincoln Laboratory). They concluded that the slow changes in work function resulted from charge transfer to and from oxygen traps on the outer surface, in agreement with conclusions reached from field-effect measurements.

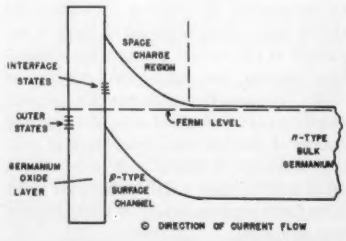

Fig. 1. Energy-level diagram of an inversion-layer-type semiconductor surface.

A. L. McWhorter (Lincoln Laboratory) reviewed theories of $1/f$ noise which consider fluctuations in the rate of charge transfer to and from the slow surface states to be the mechanism of the noise. He concluded that a combination of the multiple time-constant and the Elovitch equation was needed to fit the $1/f$ spectrum over the observed range. R. L. Petritz (Naval Ordnance Laboratory) expressed doubt that this model could explain the large magnitude of noise observed when current flows across oxide layers. He suggested that the $1/f$ noise was related to local barrier-breakdown phenomena.

R. L. Petritz, Frances L. Lummis, H. E. Sorrows and J. F. Woods (Naval Ordnance Laboratory—Woods is now at International Business Machines Corporation, and Sorrows is with the Office of Naval Research) reported surface studies on lead sulfide photoconductive films which indicate that the general model developed for germanium is also applicable to lead sulfide.

W. W. Scanlon (Naval Ordnance Laboratory) presented a new approach to the clean-surface problem. He cleaves lead sulfide crystals in an atmosphere of argon. The cleanness of the surfaces was the subject of considerable discussion.

The session on "Adsorption and catalysis" consisted of an introductory talk by P. B. Weisz (Socony-Mobil Research Laboratory) and papers by K. Hauffe (Farbwerke Höchst, Germany) and G. M. Schwab (Physikalisch-Chemisches Institut, Germany). The idea that semiconducting properties and catalytic properties are correlated presupposes that catalysis has something to do with the electronic state of the solid. Up to 10 years ago such a connection had not been firmly established. While it was clear that some sort of chemisorption had to occur as a preparatory step to catalysis, only conjectures had been made about the nature of the molecule-catalyst bond. Today it is known that in an ample number of reactions the catalytic activation consists of a transfer of electrons from the molecule to the catalyst, or vice versa. Reactions may be divided into two groups: donor reactions in which electrons are transferred to the catalyst and acceptor reactions where the electron transfer is from the catalyst to the molecule. Thus, the task of connecting semiconductor properties to catalytic action reduces to a study of how and to what degree donor reactions are catalyzed by *p*-type semiconductors, and acceptor reactions by *n*-type semiconductors. The afore-mentioned speakers presented impressive experimental and theoretical evidence that such a connection does exist.

In the final session, "Surface oxidation," N. Cabrera (University of Vir-

ginia) discussed the basic ideas of the theory of oxidation of metals. He considered first the formation of oxide nuclei, in which case nucleation controls the beginning of the oxidation, and, second, the formation of thin uniform films of oxide everywhere on the metal surface, in which case the controlling factor is the activation energy for diffusion. He emphasized the possible connection of the nucleation process with dislocations.

M. Green (now at the Zenith Corporation), J. Kafalas, and P. H. Robinson (Lincoln Laboratory) reviewed their study of the oxidation of freshly cleaved germanium surfaces. The experiment was to crush a germanium crystal in a small closed system. They find that the extent of oxidation is small, equivalent to about two layers of germanium dioxide. The oxidation is not sensitive to changes in the bulk properties of the germanium [*n* or *p*-type, high (+90°C) or low (−65°C) temperatures], indicating that the bands must be clamped at the surface as would be expected from Tamm states.

J. T. Law and P. S. Meigs (Bell Telephone Laboratories) reported measurements of the oxidation rates of the (110), (111), and (100) etched faces of single germanium crystals. The etched surfaces are initially covered with at least a monolayer of oxygen; thus, no direct comparison of the results of these investigators with those of Green can be made. The rate was measured from 500°C to 700°C as a function of oxygen pressure. From analysis of this and of other workers' data Law and Meigs summarized the present knowledge of the oxidation process as follows: at and above 550°C, the oxidation process is controlled by the diffusion of germanium monoxide away from the surface, and no effect of crystalline orientation is found; between room temperature and 550°C, few data are available, but it is probable that the (110) plane oxidizes more readily than either the (100) or the (111).

At this point, Brattain, the chairman of the session, allowed a half hour for further discussion of the question of clean surfaces. After much discussion had made it clear that a scientific settlement could not be reached, Bardeen suggested that the question be settled by the democratic process—namely, by majority vote!

The conference was concluded with a stimulating summary by J. Bardeen. He was particularly encouraged at the progress being made in determining the cross-sections and distribution in energy of the interface states. He concluded by stating that while the general characteristics of semiconductor surfaces are well established, much remains to be done in further clarifying the nature of the surface states—particularly as to what the states are and how to control them.

The University of Pennsylvania is to be thanked for its hospitality and congratulated on the excellence of the arrangements, which included a memorable banquet.

RICHARD L. PETRITZ
U.S. Naval Ordnance Laboratory, White Oak, Maryland

Meeting Notes

■ A steering committee of some 50 scientists, representing various aspects of biophysical research in this country, has organized a national biophysics conference to take place in Columbus, Ohio, 4–6 Mar. 1957. The conference will encompass studies which employ the approach of physics in biological measurement and theory, at levels of organization from molecules and cells to complex systems and psychophysics.

The program is expected to include 12 invited papers related to different biophysical fields and a large number of contributed papers. Scientists with biophysical interests may write for information on presenting contributed papers to Dr. Herman P. Schwan, School of Medicine, University of Pennsylvania, Philadelphia 4, Pa.

■ Offices of the International Atomic Exposition have been moved from Detroit, Mich., to 304 Architects Building, 117 S. 17 Street, Philadelphia 3, Pa. The next exposition will take place 11–15 Mar. 1957 in Philadelphia's Convention Hall as part of the United States Nuclear Congress, which is being sponsored by the major engineering and scientific societies.

Society Elections

■ American Microscopical Society: pres., R. P. Hall, New York University; 1st v. pres., W. T. Edmondson, University of Washington; 2nd v. pres., F. Frouet, Chicago Museum of Natural History; sec.-editor, G. W. Prescott, Michigan State University; treas., L. O. Nolf, Iowa State University.

■ Xi Sigma Pi (forestry), 1956–58: forester, L. W. R. Jackson, University of Georgia; associate forester, B. F. Grant, University of Georgia; sec.-fiscal agent, J. R. Parker, University of Georgia.

■ Society of General Physiologists: pres., Daniel Mazia, University of California, Berkeley; sec., Abraham M. Shanes, National Institutes of Health, Bethesda, Md.; treas., Irving M. Klotz, Northwestern University. Representatives to the AAAS Council are Rudolf T. Kempton and David R. Goddard.

■ American Society of Human Genetics: pres., Curt Stern, University of California; pres.-elect, William C. Boyd, Boston University; v. pres., Philip Levine, Ortho Research Foundation; sec., Eldon J. Gardner, Utah State Agricultural College; treas., Walter E. Heston, National Cancer Institute.

■ Phycological Society of America: pres., G. F. Papenfuss, University of California, Berkeley; v. pres., L. A. Whitford, North Carolina State College, Raleigh; sec., P. C. Silva, University of Illinois, Urbana; treas., R. C. Starr, Indiana University, Bloomington. Representative to the AAAS Council is Luigi Provasoli.

AAAS Finances: Report for 1955

The Association's financial records are kept in two separate accounts. One—the Operating Account—shows the expenses of running the Association's ordinary, continuing activities and the income that is devoted to those activities; the other—the Investment Account—includes funds that have been given to the Association to endow prizes, to pay the cost of maintaining the membership of emeritus and life members, and to support research.

Operating Account

Operating receipts totaled $602,420.68 during 1955. This income was divided as follows:

Annual dues paid by members	$288,808.62
Extra payments by members who wanted to receive both *Science* and *The Scientific Monthly*	18,927.37
Money transferred from the Investment Account to pay for subscriptions for emeritus and life members	3,330.00
Journal subscriptions from nonmembers	60,625.97
Sales of individual copies of journals	2,476.31
Advertising in *Science*	142,054.25
Advertising in *The Scientific Monthly*	11,615.79
Sale of symposium volumes	24,023.59
Miscellaneous sales, including journal binders, Association emblems, and microcard edition of *Science*	4,351.99
Annual meeting: registration fees, exposition space, advertising in program, and contributions	27,470.61
Income from investment of funds not needed in checking account	13,751.67
Miscellaneous other income	4,984.51
Total	$602,420.68

These receipts amounted to $8744.61 more than the operating expenses. This amount, therefore, was the Association's

surplus for the year. The principal items of expense were:

Printing and editing *Science*	$267,137.80
Printing and editing *The Scientific Monthly*	77,282.85
Editorial Board expenses and honoraria	7,136.20
Cost of selling advertising in the two journals	36,101.46
Printing and editing symposium volumes	21,736.91
Meetings of boards and committees	7,942.44
Contribution to Scientific Manpower Commission	1,000.00
Recruitment of new members	15,223.22
Expenses of the annual meeting	28,905.01
Press service for annual meeting	4,687.22
Allowances ($1 per member) to Pacific, Southwestern and Rocky Mountain, and Alaska Divisions	5,740.00
Expenses of AAAS sections	4,584.05
Administrative staff salaries and general expenses	82,340.77
Building maintenance and rental of temporary quarters during construction of new building	19,586.89
Social security, insurance, and retirement provisions for staff members	10,860.51
Miscellaneous other expenses	3,410.74
Total	$593,676.07

Comparison of 1955 with 1954

Receipts in 1955 were $7971.92 smaller than in 1954. The smaller total was chiefly accounted for by two facts: the Association derived $15,801.27 less income from the 1955 annual meeting in Atlanta than from the 1954 annual meeting in Berkeley; and the 1955 income from rent of the houses owned but not occupied by the Association was $5029.48 smaller in 1955 than in 1954. Early in 1955 those houses were torn down to make way for the new headquarters building.

Operating expenses in 1955 were greater by $27,933.28 than they were in 1954. The largest increases were in the cost of publishing the Association's journals and in the cost of housing the Association's offices. In 1955 we spent $22,703.52 more than in 1954 in editing and printing *Science* and *The Scientific Monthly*. The necessity of renting office space for most of 1955 meant that housing cost $10,354.22 more than it had in 1954.

Balance Sheet

All of the foregoing deals with the operating funds of the Association for the entire year of 1955. At the end of 1955, the Association's balance sheet showed the following assets:

Cash	$ 261,533.37
Money owed to the Association	21,991.41
Money invested in short term and easily convertible securities (for example, U.S. Treasury bills and Building and Loan Association deposits)	408,527.64
Value of real estate owned by the Association	153,297.20
Construction account for new building	479,527.42
Total assets	$1,324,877.04

Offsetting these assets, as they always must in a balance sheet, were liabilities, as listed below:

Accounts payable to others	$ 104,039.31
Unexpended portions of grants from Carnegie Corporation and National Science Foundation	97,283.93
1956 dues received, but for which members had not yet received journals or other services	223,884.14
Subscriptions to 1956 issues of journals	54,059.04
Money earmarked for construction of new building	476,756.79
Unallocated funds, available to the Association for operating expenses, payment on new building, or other purposes	368,853.83
Total liabilities	$1,324,877.04

Grants Received in 1955

Among the liabilities shown above is an item of $97,283.93 which represented the unexpended portions of grants made to the Association during 1955. Expenses, under these grants, were not listed as expenses, nor were the grants listed as income, for the grants represent special projects undertaken by the Association. They are not part of the regular operating funds, even though the purposes for which the grants were received are part of the Association's program of activities; including them in the Operating Account would give a grossly distorted picture of the Association's income and balance for the year. The grants received are briefly accounted for below.

During 1954 and 1955 the Association received grants totaling $24,770.89 to pay the expenses of the International Arid Lands Meetings held in New Mexico in April and May of 1955. The expenses of the meetings totaled exactly the same amount, and the nice balance is explained by the fact that what would otherwise have been a deficit of $1070.89 was canceled by contributions from generous supporters in the area in which the meetings were held. The other contributions to support the meetings were $10,000 from the National Science Foundation, $10,000 from the Rockefeller Foundation, $3000 from UNESCO, and $700 from the Department of State.

The National Science Foundation made three other grants to the Association during 1955. One, of $2820, was to finance a conference on the education of science teachers. The conference cost $1762.82 and the remaining $1057.18 was returned to the National Science Foundation. A second grant, of $2300, was for the purpose of holding a conference on the science training of talented students. The conference cost $1324.41 and the balance of $975.59 was returned to the National Science Foundation.

The other grant from the National Science Foundation was for $23,250 and was given to enable the Association to develop traveling libraries of books about science and scientists that were rotated during the academic year among 66 small high schools scattered throughout the United States. As of 31 December 1955 there remained $8946.70 in this account. This money was retained by the Association for the purpose of paying expenses of the program that had not yet been incurred by the end of 1955.

From the Carnegie Corporation, the Association received $100,000 on 1 July 1955. This amount was the first third of a grant of $300,000 to support the AAAS Science Teaching Improvement Program. Since the program did not get actively under way until September of 1955, there was a substantial balance of $88,337.23 on 31 December.

Members and other friends contributed $32,775.88 to the Association's building fund during 1955.

Not included in this accounting are grants of $10,000 each from the Rockefeller Foundation and the National Science Foundation that were made to the Gordon Research Conferences.

Investment Account

To keep them separated from operating funds and grants for special activities, the Association holds its endowment and investment funds in a separate Investment Account. Although the Association has some leeway in the handling of these funds, ordinarily the income is used and the principal left intact. Disbursements during 1955 were as follows:

Income allocated to Gordon Research Conferences	$1015.36
Newcomb Cleveland prize	1000.00
Socio-psychological essay prize	1000.00
Grants to academies of science to use in support of research	4612.28
Transferred to operating account to pay for journal subscriptions for emeritus and life members	3330.00
Expenses of managing investments	1742.75

The accompanying statement of receipts and disbursements from this account also shows that $273,268.50 was spent for the purchase of securities. All but a small fraction of this amount was derived from the sale of other securities.

At the end of 1955 the Investment Account showed assets of $435,340.03, of which $36,502.75 consisted of endowment for the Gordon Research Conferences and $398,837.28 was for the other purposes mentioned above. The funds in the Investment Account were distributed as follows:

	Book value	*Market value*
Cash	$ 16,334.46	$ 16,334.46
U.S. Government bonds	143,386.51	138,937.00
Other bonds	75,932.25	75,600.00
Preferred stocks	58,908.59	60,375.00
Common stocks	140,778.22	215,763.00
Total	$435,340.03	$507,009.46

Prior to 1955 a larger fraction of this account had been invested in Government securities. During 1955, with the advice of the investment firm of Scudder, Stevens and Clark, the percentage in such securities was reduced while the percentage in corporate bonds and stocks was correspondingly increased.

Auditor's Report

A condensed statement of the Association's finances for 1955, prepared by the auditing firm of G. P. Graham and Company, is published herewith. Balance sheets and statements of receipts and expenditures are given separately for the Operating Account and the Investment Account. The term "Investment Account" has been adopted to replace the older name, "Treasurer's Account," but the auditor's report uses the older name. The portion of the auditor's report published here does not include funds for the Gordon Research Conferences.

DAEL WOLFLE
Executive Officer, AAAS

Washington 5, D.C.
25 May 1956

To the Council of the
American Association for the
Advancement of Science
Washington, D.C.

We have examined the balance sheet of the Operating Fund of the American Association for the Advancement of Science as at 31 December 1955, and the statement of revenue and expenditures for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements present fairly the financial position of the Operating Fund of the American Association for the Advancement of Science as at 31 December 1955, and the results of its operations for the year then ended.

G. P. GRAHAM & COMPANY
By G. R. BOWERS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE OPERATING FUND
BALANCE SHEET AS AT 31 DECEMBER 1955

Assets

Current assets			
Cash on deposit		$258,033.37	
Imprest funds		3,075.00	
Accounts receivable		21,991.41	
Deposit with airline		425.00	
Investments		408,527.64	$ 692,052.42
Building accounts			
Investments	$ 975.87		
Real estate	153,297.20		
Building construction account	478,551.55		632,824.62
			$1,324,877.04

Liabilities

Current liabilities			
Accounts payable		$104,039.31	
Unexpended balances of grants			
Traveling High-School Science Libraries		8,946.70	
Science Teaching Improvement Program		88,337.23	$ 201,323.24
Deferred income			
Prepaid dues		$223,884.14	
Prepaid journal subscriptions		54,059.04	277,943.18
Building fund			226,756.79
Reserve fund			250,000.00
Unallocated funds			
Balance 1 January 1955		$360,109.22	
Add: Excess of revenue over expenditures		8,744.61	
Balance 31 December 1955			368,853.83
			$1,324,877.04

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE OPERATING FUND
STATEMENT OF REVENUE AND EXPENDITURES FOR THE YEAR ENDED 31 DECEMBER 1955

Revenue			
Dues			$288,808.62
Journals			
Subscriptions			
From Treasurer's accounts (Life, 50-year, and emeritus members)	$ 3,330.00		
Members' special subscriptions	18,927.37		
Nonmembers' subscriptions	60,625.97	$ 82,883.34	
Advertising		153,670.04	
Miscellaneous sales		2,476.31	239,029.69
Publications			
Binders		$ 1,268.53	
Symposium volumes		24,023.59	25,292.12
Atlanta meeting and exhibit			27,470.61
Income from investments			13,751.67
Miscellaneous			8,967.97
			$602,420.68
Expenditures			
Administrative and general expense		$ 82,340.77	
Building expenses		7,539.39	
Rental of temporary offices		12,047.50	
Board of directors		6,800.52	
Other committees		1,141.92	
Allowance to divisions		5,740.00	
Section expense		4,584.05	
Circularization–new members		15,223.22	
Meetings and exhibits		33,592.23	
Journals		387,658.31	
Publications		23,014.87	
Employees' retirement		8,008.13	
Social security		2,852.38	
Miscellaneous		3,132.78	593,676.07
Excess of revenue over expenditures			$ 8,744.61

Washington 5, D.C.
25 May 1956

To the Council of the
American Association for the
Advancement of Science
Washington, D.C.

We have examined the balance sheet of the Treasurer's accounts of the American Association for the Advancement of Science as at 31 December 1955, and the statement of cash receipts and disbursements for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as are considered necessary in the circumstances.

In our opinion, the accompanying financial statements present fairly the financial position of the Treasurer's accounts of the American Association for the Advancement of Science as at 31 December 1955, and the cash receipts and disbursements for the year then ended.

G. P. GRAHAM & COMPANY
By G. R. BOWERS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE TREASURER'S ACCOUNTS
BALANCE SHEET AS AT 31 DECEMBER 1955

Assets

Cash in bank		$ 16,334.46
Securities—at cost		382,502.82
		$398,837.28

Liabilities and Reserves

Liabilities		
Accounts payable	$ 62.00	
Academy grants	2,859.23	
Special academy grants	475.00	$ 3,396.23
Endowment funds		
For research	$174,289.52	
For general purposes	154,798.28	
For special purposes	66,353.25	395,441.05
		$398,837.28

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE TREASURER'S ACCOUNTS
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR THE YEAR ENDED 31 DECEMBER 1955

Cash balance 1 January 1955		$ 3,343.29
Receipts		
Income from investments	$ 12,368.16	
Redemption and sale of securities	270,606.76	
Life membership fees	4,650.00	
Gifts	2,919.69	
Special academy grants	450.00	
Deceased emeritus life membership fees	900.00	
Transferred to research fund income from UNESCO fellowship fund	8.50	
Refund of advance to Gordon Research Conferences	9,465.45	301,368.56
		$304,711.85
Disbursements		
Income allocated to Gordon Research Conferences	$ 1,015.36	
Securities purchased	273,268.50	
Newcomb Cleveland prize	1,000.00	
Socio-psychological prize	1,000.00	
Academy grants	4,362.28	
Special academy grants	250.00	
Emeritus life membership fees (From Jane M. Smith fund)	1,500.00	
Deceased emeritus life membership fees (To Jane M. Smith fund)	900.00	
Journal subscriptions (Life, 50-year, and emeritus members)	3,330.00	
Expenses	1,742.75	
UNESCO fellowship fund transferred to research fund income	8.50	288,377.39
Cash balance 31 December 1955		$ 16,334.46

Forthcoming Events

November

1–2. Society for Applied Spectroscopy, 11th annual, New York, N.Y. (F. M. Biffen, Johns-Manville Research Center, Manville, N.J.)

1–3. Association of Geology Teachers, annual, Chicago, Ill. (C. E. Prouty, Dept. of Geology, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

5–7. Paleontological Soc., annual, Minneapolis, Minn. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge, Mass.)

6–15. International Grassland Cong., 7th, Palmerston, New Zealand. (S. H. Saxby, P.O. Box 2298, Wellington, New Zealand.)

7–9. Electrical Techniques in Medicine and Biology, 9th annual conf., New York, N.Y. (E. D. Trout, X-Ray Dept., General Electric Co., Milwaukee 1, Wis.)

7–9. Society of Rheology, annual, Pittsburgh, Pa. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York 13.)

8–9. Canadian High Polymer Forum, 7th, Sarnia, Ont. (M. H. Jones, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ont.)

8–10. Gerontological Soc., annual, Chicago, Ill. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

10. Society for the Scientific Study of Religion, fall meeting, Cambridge, Mass. (R. W. Burhoe, American Acad. of Arts and Sciences, Cambridge 36.)

11–12. American Soc. for the Study of Arteriosclerosis, annual, Chicago, Ill. (R. G. Gould, P.O. Box 1663, Los Alamos, N.M.)

11–17. Cardiology, 5th Inter-American cong. of, Havana, Cuba. (I. Chavez, Calzada de la Piedad 300, Mexico, D.F., Mexico.)

12–14. Association of Military Surgeons of the U.S., annual, Washington, D.C. (S. E. Womeldorph, AMSUS, Suite 718, 1726 Eye St., NW, Washington 6.)

12–15. American Petroleum Inst., 36th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

12–16. American Public Health Assoc., 84th annual, Atlantic City, N.J. (R. M. Atwater, 1790 Broadway, New York 19.)

12–16. American Soc. of Agronomy, annual, Cincinnati, Ohio. (L. G. Monthey, 2702 Monroe St., Madison 5, Wis.)

13–15. Historical Development of Physiological Thought, symposium, Brooklyn, N.Y. (E. Goodwin, State Univ. of New York, College of Medicine, Brooklyn 3.)

14–15. Industrial Hygiene Foundation, 21st annual, Pittsburgh, Pa. (C. R. Walmer, IHF, Mellon Inst., Pittsburgh.)

14–16. Optics and Microwaves, symp., Washington, D.C. (Symp. on Optics and Microwaves, P.O. Box 355, Falls Church, Va.)

14–16. Newer Developments in the Diagnosis and Management of Cancer, symp., Duarte, Calif. (J. Love, Director, Div. of Postgraduate Medical Education, City of Hope Medical Center, Duarte.)

15. Enzymes and Feed, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

15–16. American Philosophical Soc., Philadelphia, Pa. (APA, 104 S. 5 St., Philadelphia 6.)

15–16. Operations Research Soc. of America, 10th natl., San Francisco, Calif. (T. E. Oberbeck, U.S. Naval Post Graduate School, Monterey, Calif.)

15–16. Society of Technical Writers, jointly with Assoc. of Technical Writers and Editors, New York, N.Y. (S. F. Shapiro, STW, P.O. Box 22, Newton Centre 59, Mass.)

15–17. Acoustical Soc. of America, Los Angeles, Calif. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

18–25. National Meeting of Surgeons, Mexico City, Mexico. (Intern. Acad. of

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Physics of the Solid State

The New Electronics	Karl Lark-Horovitz, Purdue University
Flow of Electrons and Holes in Semiconductors	J. Bardeen, University of Illinois
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Chemical Physics

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American Association for the Advancement of Science

1515 Mass. Ave., NW

Washington 5, D.C.

Proctology, 147–41 Sanford Ave., Flushing, N.Y.)

19–20. Entomological Soc. of America, Eastern Branch, Atlantic City, N.J. (B. F. Driggers, Experiment Station, New Brunswick, N.J.)

21. Arctic Branch, Alaska Div., AAAS, College, Alaska. (Miss C. Juedes, Box 47, College.)

22–23. Calder Hall Nuclear Power Station, conf., London, England. (Secretary, British Nuclear Energy Conference, 1–7 Great George St., London, S.W.1.)

22–3. International Cong. of Industrial Chemistry, 29th, Paris, France. (J. Gerard, Société de Chimie Industrielle, 28, rue Saint-Dominique, Paris VII^{e}.)

23–24. American Mathematical Soc., Evanston, Ill. (E. G. Begle, 207 Leet Oliver Memorial Hall, Yale Univ., New Haven 11, Conn.)

23–24. American Physical Soc., Chicago, Ill. (K. K. Darrow, APS, Columbia Univ., N.Y. 27.)

23–24. American Soc. of Animal Production, annual, Chicago, Ill. (W. M. Beeson, Dept. of Animal Husbandry, Purdue Univ., W. Lafayette, Ind.)

24. American Ethnological Soc., New York, N.Y. (A. G. James, Hunter College, Bronx 68, N.Y.)

25–30. American Rocket Soc., annual, New York, N.Y. (J. J. Harford, ARS, 29 W. 39 St., New York 18.)

25–30. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

26–28. American Soc. of Refrigerating Engineers, Boston, Mass. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

26–30. Automation Exposition, 3rd intern., New York, N.Y. (TIAE, Richard Rimbach Associates, Inc., 845-A Ridge Ave., Pittsburgh 12, Pa.)

27–30. American Medical Assoc., clinical, Seattle, Wash. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

27–30. National Chemical Exposition, 9th, Cleveland, Ohio. (American Chemical Soc., 1155 16 St., NW, Washington 6.)

28–30. American College of Cardiology, 5th interim, Pittsburgh, Pa. (P. Reichert, ACC, Empire State Bldg., New York, N.Y.)

28–30. International Conf. on Ozone, 1st, Chicago, Ill. (C. E. Thorp, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

30. American Rheumatism Assoc., Bethesda, Md. (E.F. Hartung, 580 Park Ave., New York, N.Y.)

30–1. Oklahoma Acad. of Science, Stillwater. (D. E. Howell, Entomology Dept., Oklahoma A. & M. College, Stillwater.)

30–1. Tennessee Acad. of Science, Murfreesboro. (D. Caplenor, Dept. of Biology, Peabody College, Nashville 4, Tenn.)

December

2. American Acad. of Dental Medicine, 11th mid-annual, New York, N.Y. (A. Reiner, 114–01 201 St., St. Albans 12, N.Y.)

2–7. Radiological Soc. of North America, Inc., annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse 2, N.Y.)

5–7. Instrumentation Conf., 2nd, Inst. of Radio Engineers, Atlanta, Ga. (M. D. Prince, Engineering Experiment Station, Georgia Inst. of Technology, Atlanta.)

6. Amino Acid Imbalance in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

6–7. American Astronautical Soc., 3rd annual, New York, N.Y. (N. V. Petersen, AAS, 516 Fifth Ave., New York 36.)

6–8. American Phytopathological Soc., annual, Cincinnati, Ohio. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)

6–9. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

7–8. Association for Research in Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 710 W. 168 St., New York 32.)

8–11. American Acad. of Optometry, annual, Houston, Tex. (C. C. Koch, 1506 Foshay Tower, Minneapolis 2, Minn.)

9–12. American Inst. of Chemical Engineers, annual, Boston, Mass. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

9–12. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, ASAE, St. Joseph, Mich.)

10–12. American Nuclear Soc., winter meeting, Washington, D.C. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

10–12. Eastern Joint Computer Conf., New York, N.Y. (J. R. Weiner, Remington Rand, Inc., 315 Fourth Ave., New York, N.Y.)

13–15. Texas Acad. of Science, annual, Brownwood, Tex. (G. C. Parker, Texas A.&M. College, College Station.)

19. Arctic Branch, Alaska Div., AAAS, College Alaska. (Miss C. Juedes, Box 47, College.)

26–31. American Assoc. for the Advancement of Science, annual, New York, N.Y. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 55 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Academy Conference (L. Taylor, West Virginia Univ., Morgantown). 29–30 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (M. Meister, Bronx High School of Science, New York 68). 27 Dec.

AAAS-Gordon Research Conferences (W. G. Parks, Univ. of Rhode Island, Kingston). 27 Dec.

Alpha Chi Sigma (H. G. Seavey, 30 Church St., Room 340, New York 7). 28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. E. Sobel, Jewish Hospital of Brooklyn, Brooklyn 16, N.Y.).

American Assoc. of Hospital Consultants (E. D. Barnett, School of Public Health, Columbia Univ., New York 32.)

American Assoc. of Scientific Workers (R. J. Rutman, 6331 Ross St., Philadelphia 44, Pa.). 29 Dec.

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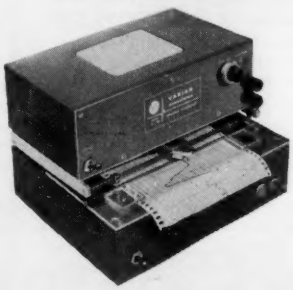

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American Astronomical Soc. (J. A. Hynek, Harvard College Observatory, Cambridge 38, Mass.). 26–29 Dec.

American Documentation Inst. (J. Hilsenrath, National Bureau of Standards, Washington 25). 27–29 Dec.

American Educational Research Assoc. (A. G. Wesman, Psychological Corp., 522 Fifth Ave., New York 36). 29 Dec.

American Meteorological Soc. (R. J. Roth, Crop-Hail Insurance Actuarial Assoc., 209 W. Jackson Blvd., Chicago, Ill.). 28 Dec.

American Museum of Natural History (G. Reekie, AMNH, Central Park West at 79 St., New York, N.Y.). 26 Dec.

American Nature Study Soc. (R. L. Weaver, Univ. of Michigan, Ann Arbor). 26–30 Dec.

American Philosophical Assoc., Eastern Div. (J. Wild, Harvard Univ., Cambridge 38, Mass.). 27 Dec.

American Psychiatric Assoc. (B. Pasamanick, Ohio State Univ., Columbus 10). 28–29 Dec.

American Soc. of Hospital Pharmacists (G. E. Archambault, U.S. Public Health Service, Washington 25). 29 Dec.

American Soc. of Range Management (F. G. Renner, Soil Conservation Service, U.S. Dept. of Agriculture, Washington 25). 28 Dec.

American Statistical Assoc. (R. E. Johnson, Western Electric Co., New York 7).

Association for Computing Machinery (J. P. Nash, Univ. of Illinois, Urbana).

Association of American Geographers (P. M. Stern, Conservation Foundation, 30 E. 40 St., New York, N.Y.).

Astronomical League (H. B. Davidson, 812 Park Ave., New York 21.)

Conference on Scientific Editorial Problems (J. G. Adashko, Ford Instrument Co., Long Island City, N.Y.). 26–28 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 26 Dec.

Ecological Soc. of America (M. F. Buell, Rutgers Univ., New Brunswick, N.J.). 26–30 Dec.

Entomological Soc. of America (P. W. Oman, Plant Industry Sta., Beltsville, Md.). 27–30 Dec.

Genetics Soc. of America (A. W. Pollister, Columbia Univ., New York 27). 28 Dec.

History of Science Soc. (Miss P. Kibre, Hunter College, New York, N.Y.). 27–29 Dec.

Institute of Mathematical Statistics (Miss E. Scott, Univ. of California, Berkeley 4).

International Council for Exceptional Children (M. H. Fouracre, Columbia Univ., New York 27). 26 Dec.

International Union for the Study of Social Insects, North American Section (T. C. Schneirla, American Museum of Natural History, Central Park West at 79 St., New York, N.Y.). 26–27 Dec.

Mountain Lake Biological Sta. (B. D. Reynolds, Univ. of Virginia, Charlottesville).

Mycological Soc. of America (L. S. Olive, Columbia Univ., New York 27). 26 Dec.

National Acad. of Economics and Political Science (D. P. Ray, George Washington Univ., Washington, D.C.). 27 Dec.

National Assoc. for Gifted Children (Miss A. F. Isaacs, 409 Clinton Springs Ave., Cincinnati, Ohio).

National Assoc. for Research in Science Teaching (N. Washton, Queens College, Flushing 67, L.I., N.Y.). 27 Dec.

National Assoc. of Biology Teachers (J. Breukelman, State Teachers College, Emporia, Kan.). 26–30 Dec.

National Assoc. of Science Writers (J. E. Pfeiffer, New Hope, Pa.).

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 29 Dec.

National Speleological Soc. (Brother G. Nicholas, LaSalle High School, Cumberland, Md.). 29 Dec.

New York Acad. of Sciences (R. F. Nigrelli, New York Zoological Soc. and M. Kopac, New York Univ., Washington Sq., New York, N.Y.). 29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Case Inst. of Technology, Cleveland, Ohio). 29–30 Dec.

Pi Gamma Mu (B. H. Williams, Industrial College of the Armed Forces, Washington 25). 26 Dec.

Scientific Research Soc. of America (D. B. Prentice, Yale Univ., New Haven, Conn.). 26–27 Dec.

Sigma Delta Epsilon (C. Chandler, Boyce Thompson Inst. for Plant Research, 1086 N. Broadway, Yonkers 3, N.Y.).

Sigma Pi Sigma (M. W. White, Pennsylvania State Univ., University Park).

Society for the Advancement of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, 2109 Broadway, New York, N.Y.). 29 Dec.

Society for the Advancement of General Systems Theory (L. von Bertalanffy, Mt. Sinai Hospital, Los Angeles 48, Calif.). 29–30 Dec.

Society for the Study of Evolution (H. Lewis, Univ. of California, Los Angeles 24). 27–29 Dec.

Society of General Physiologists (A. Shanes, National Institutes of Health, Bethesda, Md.).

Society of Systematic Zoology (R. E. Blackwelder, Box 500, Victor, N.Y.). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, Yale Univ., New Haven, Conn.). 27 Dec.

Society of Vertebrate Paleontology, annual (J. T. Gregory, Peabody Museum of Natural History, Yale Univ., New Haven, Conn.). 28–30 Dec.

Torrey Botanical Club (David Keck, New York Botanical Garden, Bronx Park, New York 58). 26–27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, PBK, 1811 Q St., NW, Washington 6). 27 Dec.

27–28. Fluid Mechanics in Chemical Engineering, American Chemical Soc., Lafayette, Ind. (W. E. Ranz, Dept. of Engineering Research, Pennsylvania State Univ., University Park.)

27–28. Linguistic Soc. of America, Philadelphia, Pa. (A. A. Hill, Box 7790, University Sta., Austin 12, Tex.)

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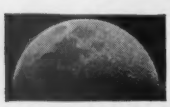

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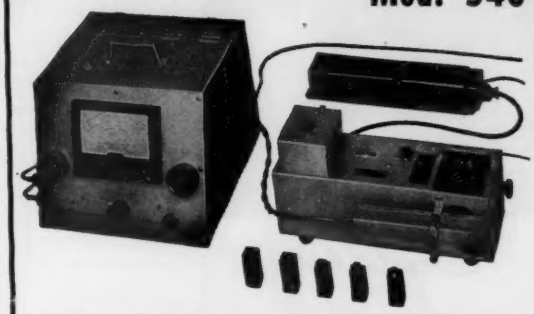

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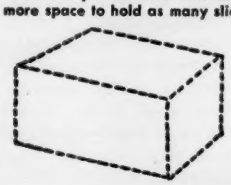

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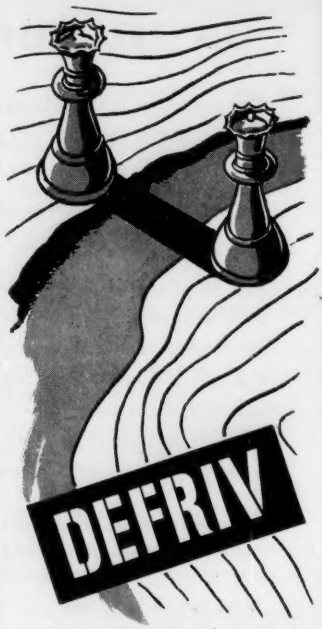

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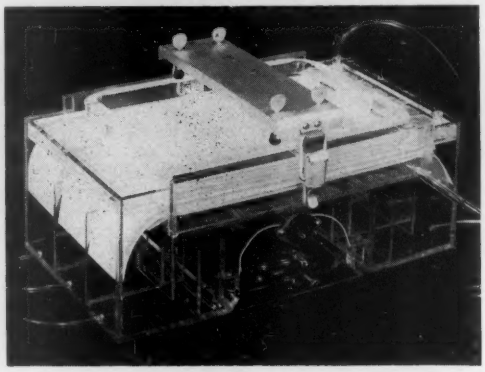

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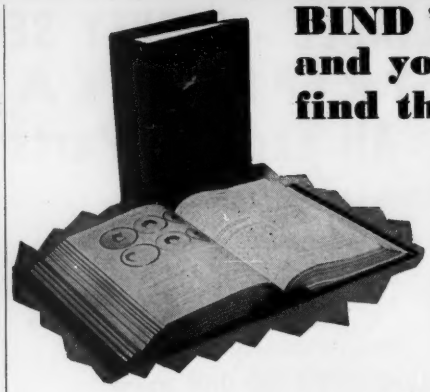

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APPLICATION FOR HOTEL RESERVATIONS

123rd AAAS MEETING

New York City, December 26-31, 1956

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. (Members of the American Astronomical Society who wish reservations at uptown hotels should correspond directly with the Hayden Planetarium.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

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Rates for Rooms with Bath*

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 20, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
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New Yorker	7.00–10.00	10.00–14.00	11.50–17.00	25.00 and up
Sheraton-McAlpin	6.75– 9.75	9.75–12.75	10.75–13.75	20.00 and up
Statler	8.00–12.00	11.00–15.00	11.50–18.00	31.00–33.00

* Subject to 5% New York City tax on hotel rooms.

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AAAS Housing Bureau
90 East 42nd Street
New York 17, N. Y.

Date of Application .....

Please reserve the following accommodations for the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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.....

First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

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(Street) (City and Zone) (State)

***Mail this now to the Housing Bureau.* Rooms will be assigned and confirmed in order of receipt of reservation.**

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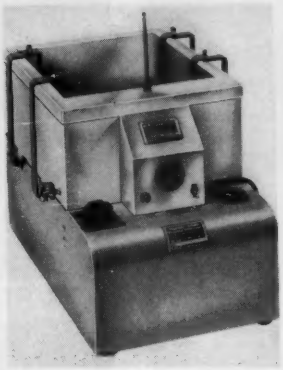

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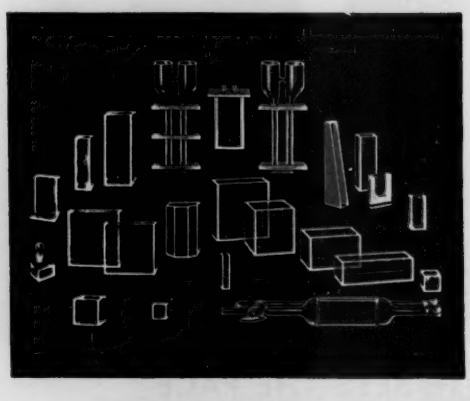

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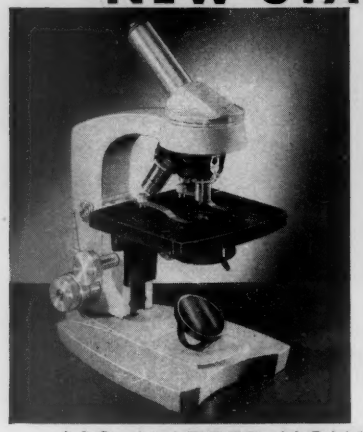
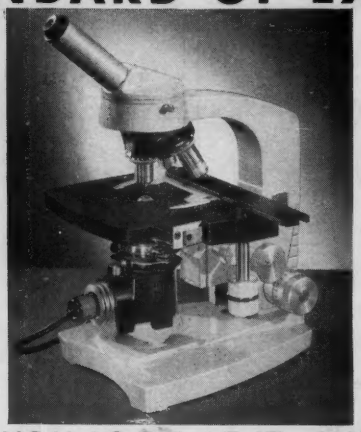
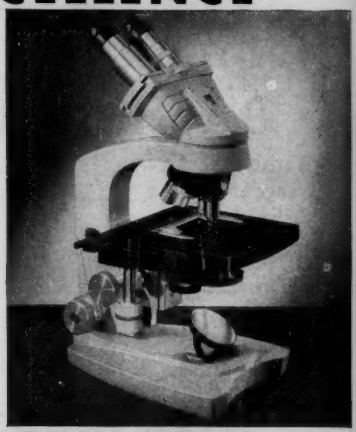

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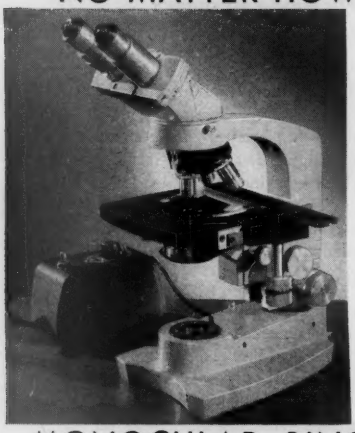
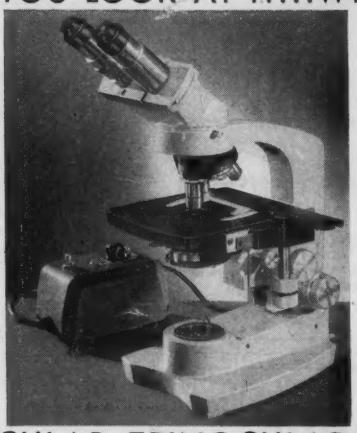
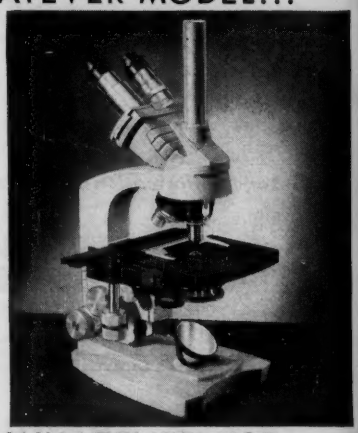

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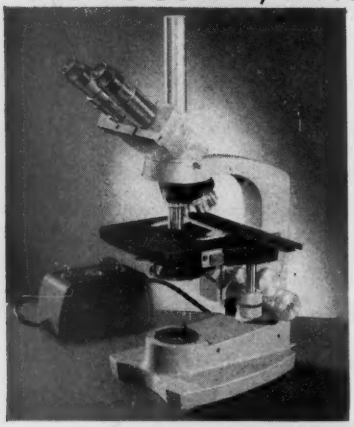
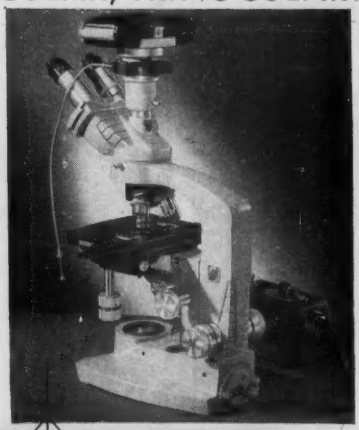
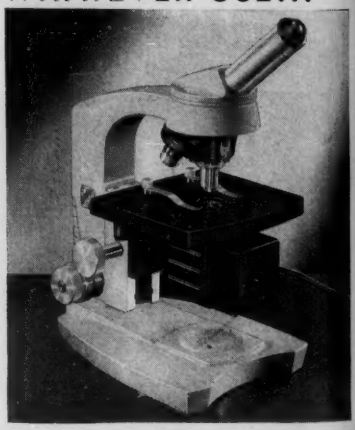

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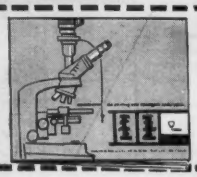

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